

SCIENCE

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THE PRESENT AND FUTURE OF BOTANY IN AMERICA¹

IF we go back a generation, say to the early '80's, we find up to this time most of the work published by American botanists was taxonomic. For some time before this, however, evidences of an awakening to other aspects of the science were evident and the next decade brought an extraordinary extension of botanical interest in other lines of work. Morphology, physiology, and especially cytology began to demand attention.

This was the period also when the government began to consider seriously the application of botanical science to the great agricultural problems of the country. Most of the agricultural experiment stations, date from this time, and it is unnecessary to point out the great influence which these have had in directing the activities of so many of the ablest workers in the field of botany.

As one looks back over this period of some thirty-five years one can not but be struck with the great increase in the number of botanical workers and the enormous number of publications recording the results of their work.

During the 70's and early 80's the opportunities for advanced work in botany, aside from purely taxonomic work, were very inadequate, even in our best universities; and students who were ambitious to avail themselves of the best instruction in botanical methods were almost perforce obliged to

¹ Presidential address of Professor Douglas H. Campbell, of Stanford University. Read before the Botanical Society of America at their dinner on December 30, 1914.

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

seek such instruction in Europe, and especially in Germany. The last decade of the nineteenth century probably witnessed the largest emigration of American botanical students to Germany. These men brought back German methods and German ideas, and undoubtedly these influences were on the whole of immense service to the development of science in America. However, it has sometimes happened that these foreign fashions, perhaps, have been followed a little too slavishly and the work of some of our foreign students might be criticized as somewhat lacking in originality.

In point of equipment and opportunity for research it may be asserted safely that at the present time, America can hold its own with any European country. It may be fairly asked, therefore, whether the accomplishment has been commensurate with the opportunities afforded.

There is no doubt that the quality as well as the quantity of work done in this country in the period in question has risen very much; and one could select a very considerable part of the work which will bear comparison with the best of its kind done abroad. But it must be admitted that the great bulk of the work is of mediocre character. It is perhaps asking too much to expect that all, or even a large part, of work of any kind should rise above the mediocre, and it must be confessed that much of the work published in the United States can not be considered to be of first rate quality. However, it is probable that the average here might be raised without undue exertion.

It seems to me that perhaps the principal cause of this mediocrity is the tendency to follow whatever new fad may come into fashion, instead of seeking for problems of one's own. We are, as a people, I think, more prone to adopt new fashions than are the more conservative inhabitants

of the Old World. At any rate the past twenty or thirty years have seen the rise and decline of a good many botanical fashions, each one of which was all-important in its day.

Instead of a man's asking himself, "What am I especially interested in and what can I do most advantageously," the student usually through the advice of his instructor, is put to work on the latest thing that has come from Germany or France, sometimes before he has really mastered the fundamentals of the science. The results of such misdirected energy are naturally often unfortunate.

Another thing which may partly account for the rarity of work of the highest grade is the undue emphasis laid on the economic phases of the science. We Americans are preeminently a "practical" people and our achievements in applied science are notorious; is it that we are incapable of recognizing the supreme importance of pure science that accounts for our comparatively poor showing in the way of contributions to the fundamentals of science, botanical or otherwise?

It is not, however, with the past history of our science that I wish to deal, but with its present tendencies and the prospects for its future development. One who has done his work and made his mistakes may be, perhaps, permitted to criticize the present and make some suggestions for the future.

The equipment of our more important universities, as well as the liberal provision made by the government for scientific work, in connection with special private endowments for research work, offer ample opportunity to the man who would devote his life to a scientific career.

Unfortunately the very perfection of the material equipment may cause us to attach undue importance to the mere apparatus of research, and to minimize the value of

the man who is to use this elaborate paraphernalia.

I sometimes think that there is danger of our becoming slaves to our machinery. Life, alas! is too short to spend any unnecessary time in over-elaborate and complicated methods where simple and direct ones would answer every purpose. That much time is wasted in many laboratories through the employment of unnecessarily complicated methods, I firmly believe.

Another phase which I think has been overdone in America is the mania for standardizing everything. Elaborate systems of recording results are often so complicated as to be quite bewildering to the worker trained in old-fashioned ways, and he wonders sometimes at the very small output of work resulting from this imposing mass of machinery until he realizes that pretty much all of one's time must be consumed in keeping the machinery going.

While the standardization of science, like that of automobiles, may result in a good general average, and make for convenience and cheapness, it does not result in the highest type of work. The really big work in science must be done by men who are a law unto themselves. The highest type of original work can not be made to conform to fixed rules and regulations, and our American love of machinery and standardized methods is, it seems to me, detrimental to the development of originality.

A problem that is always with us is the question of teaching versus research, and how far the two are compatible. I think we must all admit that the teacher, at least in the university, should be an investigator. Indeed it is hard to see how a teacher who himself is not engaged in research can expect to inspire in his students a desire to become investigators. The vexed question of the relative importance of teaching and research can hardly be an-

swered satisfactorily. Of course it is incumbent on every teacher to see that his teaching work is faithfully performed; but on the other hand the man who is capable of carrying on important researches and is willing to do so, has claims which every university worthy of the name is bound to respect.

So far as my own observation goes, it seems to me that the two are not incompatible, but I must also confess that it usually happens that whichever is the more congenial is likely to receive the greater attention.

I have very little faith in the assertion so often made that the time necessary for teaching is so great that no time is left for research. When one reckons up the time actually demanded of instructors in a well-equipped university and compares it with the time demanded of the average business or professional man, one must admit that the university professor has a very much greater amount of spare time at his disposal, which, if he really wishes to do so, he may devote to research. Too many of our teachers make work for themselves which is quite unnecessary and is a sad devourer of time, but which sometimes at any rate affords a convenient explanation of why they do not accomplish the great results which they would invariably do if only opportunity permitted. What a man wants to do most, he is pretty sure to accomplish, and if investigation is really what he is most interested in, he will find some means of doing it.

Of course, all men who occupy university chairs are not for that reason necessarily devotees of research, although I believe no man should be appointed to a university professorship who has not demonstrated his ability to advance knowledge in his chosen branch, and it should be expected

of him that his researches do not cease with his attainment of a professorship.

The excuse is often offered that the professor is frequently subject to interruptions which interfere with research work. I notice, however, that such interruptions are quite as often as not the fault of the man himself, whose sociable disposition or inability to concentrate his attention as well as the fatal tendency to "putter," eat up the time which ought to be devoted to investigation and which, if properly utilized, would soon show substantial results.

It is easy to find fault and criticize but when it comes to suggesting remedies for the future, the problem is a difficult one. First of all, perhaps, is getting hold of the right men, and next, after getting them, to see that they make the most of their natural talents.

In these days of commercial ideals when the value of everything is gauged by what it will bring in the market, and especially in this country where the opportunities for easy money-making are probably greater than anywhere else in this world, it is not strange that most of our young men become early infected with prevailing standards of values. One indeed must have a very strong love of science for itself to withstand the lure of the market place. To realize after years of hard work and expensive training that a man may in case he devotes himself to pure science have to serve for a lesser wage than is paid an expert bricklayer or carpenter, does not offer a very alluring prospect to most able and energetic young men. Nevertheless, if we are to develop men to do the highest type of work, we must in some way persuade them to take these chances.

Of course, before urging a young man to devote his life to a career at best pecuniarily far below what he might reasonably expect to earn in some other calling, we

should be very sure that our youth gives something more than a vague promise that he is likely to accomplish something really worth while in the branch he has chosen.

This is perhaps our most difficult task. We all have seen young men, bright and alert, who are immensely interested in their investigations just so long as you set them the problem and superintend the work, giving from time to time the necessary suggestions and encouragement. The question is, will they devise problems for themselves and carry them through without some one at their elbow to give them assistance when they come to a difficult place.

It is very hard to recognize the men who have this initiative and with it the perseverance and resourcefulness which mark the born investigator; and I believe there *are* born investigators, just as truly as there are born poets and painters. You can cultivate the gift but you can not create it. How we are to discover our budding genius, however, and how we are to hold him when caught is another matter.

While undoubtedly there is much encouragement to be derived from the progress we have made during the past generation, still we may learn a lesson from this which may help us to direct the work of the next generation so as to yield still better results.

I can not but feel that we very much need to have the importance of pure scientific work as an end in itself strongly insisted upon. This I believe is one of our hardest problems. In the face of the constant demand for men trained in technical lines and the indisputable importance of the many economic problems that confront us, it is hard to make the average hard-headed young American see the beauty of science for its own sake. Our whole social system and modern trend of educational methods both tend to magnify the importance of

technical training when compared with education as an end itself. Every one can appreciate the value of making two blades of grass grow where before there was but one, but the man who makes new ideas sprout is too apt to be looked upon as a harmless crank, if indeed he is regarded at all.

It may be that a reform in our educational system is necessary. There are symptoms of a revolt against the extreme utilitarian views now current, and it is possible that we may see a tendency to return, in part at least, to the older educational ideals. There can be no question that greater attention paid to the humanities would encourage a love for pure science as contrasted with applied science. The student who has had a sound training in literature, history, language, and in the whole range of what we term the "humanities" will certainly have a broader outlook than the man whose training has been severely vocational. Such a student will be far more likely to appreciate the value of purely scientific work whose importance is to be measured in terms of intellectual satisfaction rather than in dollars and cents.

This, then, I believe, is one way by which we may hope to recruit the ranks of investigators in the higher lines of science. Another benefit which would result from a more liberal training of the majority of our university students would be a far greater appreciation of the results of such scientific work by men who are not themselves scientists. It may be hoped after we pass beyond the era of great accumulation of wealth that there will be a greater appreciation of the less material results of the higher education. Just now, it must be confessed, this era does not appear to be imminent.

Having secured our special man, our next concern is to see that his efficiency is developed to the utmost. While, of course, it is essential that our man must first receive a

thorough training in the fundamentals of botany, when the time comes for him to venture on original research every effort should be made to discover where his special ability lies, and we should not try to force him to work along lines which are especially attractive to ourselves, should he show a strong bent for work in some other direction. Here is where the danger of trying to follow the latest fashion comes in. It is very likely that our student may have a very lukewarm interest in Karyokinesis, Mendelism, Mutation, or whatever the latest thing may be, and an effort to force him into these subjects contrary to his own preference may result disastrously.

Of course, in directing the work of students, and we might also say in the selection of our own subjects for research, we have to consider not only the importance of the topics, but also—and this is very important—their practicability. I do not mean by this that we are to look for easy subjects, but there are too many fascinating problems, such for instance as the physical basis of hereditary transmission, which from their very complexity seem almost hopeless of solution, although we can make no end of ingenious hypotheses, almost as many indeed as there are investigators. Such investigations are almost certain to be inconclusive and it is very questionable whether, in many cases, time devoted to these might not better have been dedicated to something more likely to yield more tangible results. In this connection it may not, perhaps, be impertinent to call attention to the very loose way in which much of the work now so popular on the problems of heredity is carried on. The tendencies to assume that the phenomena observed, in animals for example, are also immediately applicable to plants and *vice versa* has led to a great deal of inaccurate thinking and writing.

It can hardly be said that any special

phase of botany is urgently demanding attention or is being noticeably neglected; nor can it be said that there is not abundant material awaiting the botanist in pretty much any line he may choose. One might, however, urge that our botanists seek out problems for themselves rather than borrow them from our foreign colleagues. There are surely enough original problems awaiting solution at home to keep our botanists fully occupied. The United States with its varied flora and extraordinary range of conditions gives the American botanists a great advantage over their European colleagues, advantages which, perhaps, have not always been appreciated to their full extent.

The flora itself, even the vascular plants, is very far from being even fully catalogued and a wide field is open to the trained botanist for investigation of its distribution and relations. These problems of geographical distribution, and of the origins of the different floral elements of our country are full of interest and deserve much more attention than has yet been given them. The man who will write a compendious and well-balanced account of the distribution of the plants of the United States will deserve well of his botanical brethren.

While the vascular plants of this country have received much attention from the systematists and there are numerous excellent manuals dealing with them, the lower plants have not, perhaps, received a corresponding amount of attention. There is still room for handbooks dealing with most of the lower groups of plants, which can be used by the student to identify them. Perhaps more than anything else a manual of the marine algae is needed.

Passing to another phase of taxonomy, attention may be called to the need for a radical revision of the classification of the seed plants. Perhaps the time is not yet

ripe for this, but it is abundantly clear that the classification now in use is very far from indicating all the real relations. Among the Angiospermous plants, for instance, I believe it will soon be generally admitted that the present division into Monocotyledons and Dicotyledons is a more or less artificial one. It is very necessary that the lower and more generalized families of both Monocotyledons and Dicotyledons should be studied critically with a view to determining the relations of these to the more specialized ones. Any one who has done any practical work in this direction realizes the difficulties of the problem, but I do not believe these difficulties are insuperable. The work calls for much laborious research, often ending in negative results; but from my own experience, I believe that finally we shall arrive in this way at a much clearer understanding of the relations existing between the families of both Monocotyledons and Dicotyledons than we now possess, and that we may hope for a final clearing up of the relations of these two groups to each other.

It is to be hoped that our students of fossil plants by patient searching may finally bring to light material which will do for the Angiospermous plants what has been done by the brilliant researches of the past few years on the geological history of the Pteridophytes and Gymnosperms.

Just at present there is great interest taken in the question of the so-called "mutations" and much inquiry as to their real meaning and their bearing upon the origin of species, one writer—Lotsy—going so far as to claim that all new species originate as hybrids, a hypothesis which few would be willing to accept without many reservations, although there is no question that what are apparently good species have so originated in nature. This study of natural hybrids has been but little pursued in

this country and offers a very fertile field for investigation.

Another phase of the origin of new forms is one which opens up a large field for research and ought to yield valuable results. This is the study of the changes in naturalized plants. In all the older parts of this country there are very many naturalized plants, principally weeds, which have been brought from abroad and are mostly of European origin. Many of these must have been introduced very early in the settlement of the country, so that some of them have been subjected to new environmental conditions for a period of nearly three hundred years. This ought in some cases to have resulted in perceptible changes, especially as these plants have not been subjected to the same keen struggle for existence which exists in their native habitat, and sometimes at least, grow in their new home with a vigor that one does not see in their native land. It seems to me that a careful study of some of these introduced weeds in their new environment and a comparison with the same species at home ought to furnish some valuable data in regard to some of the factors concerned in the origin of new species.

Finally, a critical study of variation in our native plants and the conditions associated with these should be of value in this same connection. In California, especially, the variations within the species are sometimes very marked and make the separation of species extremely difficult. While some of these variations can be explained by the difference in the conditions under which they grow, this is not always the case, and undoubtedly there are marked individual variations which can not be so explained. Such studies made upon plants in their natural surroundings should be more valuable than those based on plants growing under artificial conditions.

What then is the present outlook for botany in America? Facilities are certainly not wanting; equipment and aids to research are equal to those anywhere, and there surely is no lack of material and of problems awaiting the right men.

Are we going to attract to our profession men of such capacity that the next generation is to win results commensurate with the opportunities furnished by this rich and generous country? Let us hope that we shall soon become educated sufficiently to appreciate the labors of the scientist apart from their immediate pecuniary value, and that the men who are endeavoring to extend the boundaries of knowledge shall receive adequate recognition. When this is true, I think we may count on adding able recruits to our forces, and these botanists of a later day will be no mere adopters of ideas borrowed from foreign sources, but will be original investigators in the truest sense of the word. These men will appreciate the wealth of material lying immediately to hand and the important problems of American botany will receive full attention. Of course, I would not urge narrow provincialism in the choice of subjects—that is as far as possible from my thought—but I mean that the investigator should seek inspiration from the sources to which he has immediate access and not get it second hand, no matter how illustrious the source of inspiration may be.

Only by this reliance upon himself by the investigator can work of the highest kind be accomplished.

DOUGLAS H. CAMPBELL

THE CARNEGIE INSTITUTION OF WASHINGTON¹

NEARLY thirteen years have now elapsed since the foundation of the institution in

¹ From the report of the president, Dr. R. S. Woodward, for the year ending October 31, 1914.

1902. A majority of the larger departments of research established under the direct auspices of the institution have been effectively at work for about a decade; while investigations of numerous individuals, primarily connected mostly with academic and other organizations, have been promoted for an approximately equal period of time. Thus, although this must be regarded as a very short interval in the career of an establishment whose history should be measured by centuries, it has been long enough to afford surprisingly large opportunities for the development of ideas and ideals concerning the conduct of research. In addition to the necessarily limited number of investigations actually undertaken by the institution, it has entertained proposals for research in nearly every imaginable field of abstract thought and of applied knowledge. If under these circumstances the institution has not learned something of the wisdom which is said to arise from experience, lack of abundance thereof can not be properly assigned as a reason for so obvious a lapse. An adequate account of this very extensive and very complex experience, which, while overloaded with the manifest and the impracticable, is yet rich in applicable instruction, may not be attempted here; an appropriate objective treatment would require a separate volume and another author. But it may be useful to contemporaries to set down here a few salient propositions, which, like those stated formally in my report for 1912, have been amply verified.

Thus, as regards research and the conditions favorable thereto, it is in evidence—

1. That it is inimical to progress to look upon research as akin to occultism and especially inimical to mistake able investigators for abnormal men. Successful research requires neither any peculiar conformity nor any peculiar deformity of mind. It requires, rather, peculiar normality and unusual patience and industry.

2. That fruitful research entails, in general, prolonged and arduous if not exhausting labor, for which all of the investigator's time is none too much. Little productive work in this line may be expected from those who are ab-

sorbingly preoccupied with other affairs. Herein, as well as in other vocations, it is difficult to serve two or more exacting masters.

3. That those most likely to produce important results in research are those who have already proved capacity for effectiveness therein and who are at the same time able to devote the bulk of their energies thereto. In general, men are not qualified for the responsibilities of research until they have completed independently and published several worthy investigations.

4. That research, like architecture and engineering, is increasingly effective in proportion as it is carefully planned and executed in accordance with definite programs. A characteristic defect of a large majority of the proposals for research submitted to the institution is a lack of tangible specifications. Estimates, especially of time and funds essential to carry out such proposals, are almost always too small. Those commonly made, even by skilled investigators, may be on the average safely doubled.

5. That, in spite of the most painstaking foresight, research tends to expand more rapidly and hence to demand a more rapid increase of resources than most other realms of endeavor. Its unexpected developments are often more important than its anticipated results and new lines of inquiry often become more urgent than those carefully prearranged for pursuit.

6. That it is much easier, in general, to do effective work of research in the older fields of inquiry than in the newer ones. It is especially difficult to enter those fields in which there is as yet no consensus of opinion concerning what may be investigated and what criteria may be followed. In some of the older fields, however, like the so-called humanities, for example, there is at present no such consensus of opinion, if one may judge from the large mass of expert but hopelessly conflicting testimony furnished to the institution by its correspondents. In such fields it appears now practicable to proceed only in a somewhat arbitrary fashion, accomplishing here and there good pieces of work regardless of divided opinions or even in opposition to expert

advice, in illustration of which may be cited the institution's publications of the "Old Yellow Book" and the "Arthurian Romances."

The larger departments of research of the institution are now so well established and so distinctive in their several fields that they might be regarded as so many separate organizations except for their dependence on the institution for financial support. They are not uncommonly considered, in fact, as independent organizations, while several of them have been mistaken for the institution as a whole. Such misapprehensions are inevitable, but their existence suggests a question well worthy of reflection, namely, whether it may not be well, in the course of time, for some, or all, of these departments to sever connections with the institution if they should have the good fortune to receive adequate separate endowments. The only concern the institution need have in such circumstances is that of securing to these departments the most favorable conditions for effective work. If this object may be best attained by independent foundations, or by affiliation with other organizations, no obstacle should be raised against such action.

But quite apart from these hypothetical considerations, the existing relations of these departments to one another and to the institution as a whole secure to them a degree of autonomy which could hardly be surpassed under other auspices. The liberties of action, thus designedly and freely conceded, imply corresponding responsibilities not only in departmental administration but also in departmental exposition, whether by summary annual reports or by elaborate monographs. Accordingly, and in conformity with other reasons referred to in previous reports, the following paragraphs aim to give brief indications only of departmental progress, reference being made for instructive details to the reports of the several directors in the current year book.

In connection with the subject of departmental researches particularly, the question is often asked "How can the 'practical results' attained be popularized and thus rendered available to the masses of mankind?" This is a question too large and too difficult for adequate discussion here, but it is one merit-

ing studious contemplation in the interests of our successors. It may be recalled that a hopeful paragraph was devoted to this topic in my first annual report, of 1905, but subsequent experience does not seem to justify the optimism entertained at that time. It is now plain, indeed, that while as a matter of fact truth is not only stranger but much more important than fiction, contemporary media for the dissemination of the sensational and the intangible are far more numerous and potent than the media for the dissemination of the demonstrable, and hence permanent, additions to knowledge. And it is equally plain that until there is an increased demand for less of the spectacular and for more of the real, both from journalists and from their readers, there can be little improvement in the popularization of discoveries and advances through such media. In the meantime, the increasing value of these researches, now everywhere recognized by scholars, may presently justify the engagement of an expert to popularize not simply the "practical results" but to furnish also what is in general more important, to wit, a clear and concise account of the principles and the methods by which such results are derived.

DEPARTMENT OF BOTANICAL RESEARCH

Although the greater part of the work of this department is carried on at its principal laboratory at Tucson, Arizona, it is essential to a comprehensive study of desert plant life to explore distant as well as adjacent arid regions. Thus, having published during the past year the results of an elaborate investigation of the region of the Salton Sea, the department is now, among many other activities, turning attention to similar desert basins, of which there are several in the western states that have been studied hitherto in their geological rather than botanical aspects. These researches are entailing also many applications of the allied physical sciences not heretofore invoked to any marked extent in aid of botanical science. Hence there results properly a diversity of work quite beyond the implications of botany in the earlier, but now quite too narrow, sense of the word.

In addition to the work carried on by members of the departmental staff, various investigations have been pursued by about twenty collaborators, several of whom have been in temporary residence at the Desert Laboratory. Among the more noteworthy publications emanating from the department during the year may be cited, along with the monograph on the Salton Sea referred to above, the instructive volume by Dr. Forrest Shreve, of the departmental staff, on "A Montane Rain-Forest" (Publication 199 of the institution). Favorable progress has been made by Messrs. Britton and Rose, research associates of the department, in their elaborate investigation of the distribution and relationships of the Cactaceæ. The facilities of the Desert Laboratory have been enlarged during the year by the completion and equipment of a specially designed small building for studies in phytochemistry, which has been proved to play a highly significant rôle in desert life.

DEPARTMENT OF ECONOMICS AND SOCIOLOGY

The work of this department has been confined in recent years to the preparation of divisional monographs, as explained in previous reports. Dr. Victor S. Clark, in charge of the division of manufactures, has been able to devote his time exclusively to this work and has been furnished office quarters for this purpose in the administration building at Washington. Other heads of divisions have been able to give half or less time to their divisional work, which is thus progressing somewhat more favorably than hitherto. It is hoped, therefore, that some of the monographs under way may be ready for publication during the coming year. Of the comprehensive "Index of Economic Material in the Documents of the States" projected by the department and prepared under the direction of Miss A. R. Hasse, the volume for New Jersey is now in press. Volumes of this index for eleven different states have already been issued.

DEPARTMENT OF EXPERIMENTAL EVOLUTION

The observational, statistical and physical methods applied by this department are constantly adding to the sum of facts and of in-

ductions essential to advances in biological knowledge. The range of application extends from the lowest organisms, like fungi, up to the highest, as typified in the race to which the investigators themselves belong. Thus, during the past year, observations and experiments have been made on mucors, plants, pigeons, poultry and seeds, while the director has continued his fruitful statistical studies in the relatively new field of departures from normality in mankind. The variety of agencies employed in this wide range of inquiry now includes a permanent staff of about twenty members and a physical equipment enlarged during the year by the completion of an additional laboratory and a power-house. Early in the year the facilities of the department were increased by the successful transfer, from Chicago to Cold Spring Harbor, of the remarkable collection of pedigreed pigeons recently acquired by the institution from the estate of Professor C. O. Whitman.

Among the numerous researches of the year to which attention is given in the departmental report, there may be cited, as of special interest, those of the director in human heredity, those of Dr. Blakeslee and Dr. Gortner on mucors, those of Dr. Riddle on the Whitman pigeons, those of Dr. Harris on the characteristics of seeds, and those in cytology by Mr. Metz. It is of particular interest to note that, in all of these, definite, measurable relations are anticipated as attainable, just as such relations are now assumed to be attainable in the older physical sciences. The director accepted an invitation from the New Zealand government and from the British Association for the Advancement of Science to take part in a series of scientific conferences held in Australasia during the past summer. Dr. Shull, of the departmental staff, spent the year in Berlin preparing his account of the horticultural work of Luther Burbank. The department expresses regret at the loss from its staff of Dr. R. A. Gortner, who has resigned to accept a position in the University of Minnesota. His abilities as an investigator and his capacity for effective cooperation won high regard from his colleagues.

GEOPHYSICAL LABORATORY

An instructive example of the favorable progress, which may be confidently expected in any field of research when entered by an adequately manned and equipped department devoted solely thereto, is afforded by the experience of the geophysical laboratory. In less than a decade this establishment has not only accomplished the formidable task of constructing the necessary apparatus and of preparing many of the pure minerals concerned, but has already begun the processes of analysis and synthesis which are leading to extensive additions to our knowledge of rock and mineral formations found in the earth's crust. In illustration of these processes the director's report cites the mineral system dependent on the elements lime, alumina and silica, which elements include in their multifarious possible combinations the well-known but hitherto little understood compound called Portland cement, whose properties have been determined as an incident to the general problem presented by this system.

Among the numerous problems under investigation at the laboratory, one of immediate economic as well as of great theoretical interest may be cited here by reason especially of the fact that funds for its execution have been supplied by industrial sources; this is the problem of the "secondary enrichment of copper ores," and the success attained in its treatment demonstrates the practicability of advantageous cooperation between the laboratory and industrial organizations without restriction to scientific procedure and publicity. The section of the director's report devoted to this subject should be of special interest to geologists and to mining engineers as well as to copper-mining industries. A more comprehensive idea of the productive activities of the laboratory may be gained by a glance at the section of the director's report in which he gives brief abstracts of the publications which have emanated from members of the staff during the year. These publications embrace forty-nine titles of papers which have appeared in current journals or are in

press, many of them having been published in German as well as in English.

DEPARTMENT OF HISTORICAL RESEARCH

The investigations of the department of historical research have proceeded effectively in accordance with the plans outlined by the director in his reports published in previous year books. In addition to the members of the permanent staff, several collaborators have taken part in these investigations, which have required explorations of historical archives in England, Scotland, France, Spain, Holland, Russia and Switzerland. Departmental plans for pursuit of peaceful studies in foreign archives, however, have suffered a serious check in the onset of the European war, and much work well started, or approaching completion, must now await developments from the pending conflict.

Two bulky volumes of guides to the sources of American history have issued from the department during the year as Publications 90A and 90B of the institution. These are, respectively, "Guide to the Materials for American History to 1783, in the Public Record Office of Great Britain," and "Guide to the Materials in London Archives for the History of the United States since 1783." It had been anticipated that a similar guide to the data on American history in the archives and libraries of Paris, in preparation under the charge of Mr. Leland of the departmental staff, would be completed before the end of the present calendar year; but the exigencies of the war have required the suspension of this work at Paris and the return of Mr. Leland to the departmental office in Washington. Similarly, work undertaken for the department in Holland by Professor William I. Hull and in Spain by Mr. Francis S. Philbrick had to be suspended. On the other hand, researches under way in Great Britain and in Russia have suffered little interruption. Work at the home office has proceeded without discontinuity. The director calls attention particularly to progress made in work on the projected "Atlas of the Historical Geography of the United States." Two divisions of this

atlas, illustrating respectively the history of presidential elections and the records of votes cast in the House of Representatives for or against certain typical measures of legislation, extending from 1789 to 1914, are already well advanced.

DEPARTMENT OF MARINE BIOLOGY

In accordance with plans recommended by the director of the department of marine biology and approved by the trustees in 1912, an expedition to Torres Straits, Australia, a region already known to be remarkable for abundance and variety of marine life, was undertaken in the latter part of the preceding fiscal year. Early in September, 1913, the director and six collaborators arrived at Thursday Island in the Straits, expecting to use this relatively accessible island as a base of explorations; but it was soon found advantageous to locate on Maër Island, one of the Murray group, about 120 miles east-northeast, and near to the outer limit of Great Barrier Reef. Here a temporary laboratory was set up in the local courthouse and jail, generously placed at Dr. Mayer's disposal by the British authorities. The region proved to be one rich in coral reefs and in marine fauna for the work contemplated. Observations and experiments securing gratifying results were carried out during the spring months (in the southern hemisphere) of September and October, 1913. In addition to the critical data secured by Dr. Mayer with respect to the corals about Maër Island, for comparison especially with corresponding data from the corals of Florida waters, observations and materials for important contributions to zoology were collected by each of his collaborators. One report, by Dr. H. L. Clark, is now in process of publication and is remarkable for the new species of echinoderms described and for the admirable drawings of these forms made from life by Mr. E. M. Grosse, of Sydney, Australia, who accompanied the expedition.

On returning to America from the southern hemisphere, the director was engaged, during April and May, in two minor expeditions with

the departmental vessel *Anton Dohrn*. The first of these was in aid of the researches of Dr. Paul Bartsch, on cerions, and required a cruise along the Florida Keys from Miami to Tortugas and return. The second expedition was in aid especially of Dr. T. W. Vaughan, long associated with the department in studies of corals and related deposits, and required a cruise from Miami, Florida, to the Bahamas and return. On June 9, 1914, work was resumed at the Tortugas Laboratory and continued until July 30. In all, fifteen collaborators during the year have availed themselves of the facilities afforded by the department. Brief accounts of their varied researches may be found in the director's report in the current year book, while detailed accounts may be expected in due time in the departmental contributions.

Attention is invited to an interesting section of the director's report devoted to a summary of the work accomplished by the department during the first decade of its existence. This section is instructive in showing that a decade is the smallest convenient unit of time for adequate estimation of the activities of such an establishment. It appears that during this decade 49 investigators have made use of the Tortugas laboratory, 28 of these having returned two or more times, making a total of 108 visits to this relatively inaccessible center of research. Of the publications emanating from the department, 60 have been published by the institution, while upwards of 40 have been published under other auspices; the institution has issued 2,551 printed pages and 269 plates exclusive of annual reports appearing in the year books.

DEPARTMENT OF MERIDIAN ASTROMETRY

The activities of the department of meridian astrometry are concentrated on the derivation of stellar positions for the comprehensive catalogue in preparation, on supplementary measurements of stellar coordinates with the meridian circle of the Dudley Observatory, and on investigations of residual stellar motions. The latter have now become the most important element in the definition

of stellar positions by reason of the extraordinary recent progress in sidereal astronomy, to which the department has contributed in large degree. Thus, along with the formidable computations required by the large mass of observations made by the department at San Luis, Argentina, researches are simultaneously continued on the problems of the star-drift, including the speed and direction of motion of our solar system. In the meantime, the catalogue is progressing favorably and some portions of the observatory list of miscellaneous stars are approaching completion, although cloudiness during the past two winters has interfered with this part of the departmental program. In the meantime, also, the manuscript of the zone catalogue of stars whose positions were measured at the observatory during the years 1896 to 1900 is undergoing the final process of comparison and checking preparatory to publication.

THE NUTRITION LABORATORY

The anticipations of a specially favorable environment, which were entertained when the nutrition laboratory was located in Boston near the Harvard Medical School and near several existing and projected hospitals, are now fully realized; and it would appear that the laboratory is reciprocally advantageous to the several establishments with which it is in immediate contact. Indeed, with this, as with all other departments of research founded by the institution, the only fears to be seriously entertained are those due to increasing capacity for usefulness and scientific progress, since such capacity tends quite properly to grow faster than the institution's income warrants.

The completion of adjacent buildings and streets has permitted bringing the grounds of the laboratory into harmony with its physical surroundings. Improvements have been made in the laboratory itself and several additions to equipment have been installed. These latter include new respiration apparatus for studies of metabolism in muscular work of men and of small animals, a reconstruction of an earlier form of bed calorimeter, and addi-

tional apparatus for photo-electric registration of physiological action in subjects under observation, whether near by or at a distance.

As indicated in previous reports, the laboratory and its work are subjects of international as well as national interest and many cooperative efforts are arising therefrom. Thus, Dr. Hans Murschhauser, of the *Kind-erklinik* in Düsseldorf, and Dr. Carl Tigerstedt, of Helsingfors, have each spent several months at the laboratory during the year as research associates; while M. Lucien Bull, assistant director of the *Institut Marey*, in Paris, spent several weeks at the laboratory studying its apparatus and methods. The researches in progress by the laboratory staff are briefly summarized by the director under twenty different heads in his annual report, to which reference must be made for personal and technical details. Abstracts are given also in his report of the publications issued during the year or now in press. Of these, attention may be called particularly to "The Gaseous Metabolism of Infants with Special Reference to its Relation to Pulse-rate and Muscular Activity," by Francis G. Benedict and Fritz B. Talbot (Publication No. 201) and to "A Study of Prolonged Fasting," by Francis G. Benedict (in press as Publication No. 203).

DEPARTMENT OF TERRESTRIAL MAGNETISM

The extensive operations of the department of terrestrial magnetism on the oceans and in foreign countries have been adequately supplemented during the year by the new departmental laboratory, whose completion and occupation took place nearly simultaneously with the beginning of the second decade of the department's existence. This laboratory and its site provide greatly enlarged facilities for research as well as unsurpassed quarters for the resident departmental staff. This site (of 7.4 acres) is well protected on all sides from possible objectionable elements, while the laboratory is an exceptionally well-lighted, fire-proof building with 44 rooms and many specially designed adjuncts. Attention may be invited particularly to the relatively low

cost (22 cents per cubic foot) of this building, and to the reasons why it, like the geophysical laboratory and the nutrition laboratory, has been economically built. These reasons are found mainly in deliberate preparation of preliminary programs, in carefully drawn plans and specifications by competent architects, and in responsible superintendence of construction.

Near the end of the preceding fiscal year the non-magnetic ship *Carnegie* returned to New York City, where she underwent such extensive repairs as are always required by wooden vessels after long cruises in tropical waters. After refitting, she left New York, June 8, 1914, for a cruise in the North Atlantic. In this, the third of her expeditions, she traversed about 10,600 miles, making a first stop at Hammerfest, Norway, July 3, reaching the high latitude $79^{\circ} 52'$ off the northwest coast of Spitzbergen, touching at Reykjavik, Iceland, August 24, and returning to the base station at Greenport, Long Island, October 9, and to Brooklyn, New York, October 21. During this cruise the *Carnegie* was in command of Mr. J. P. Ault. She is now refitting for a longer cruise during 1915-1916, in southern latitudes (50° to 75°), where magnetic observations require supplementing.

An attempt at an ocean expedition into Hudson Bay was made under the charge of Mr. W. J. Peters during the past summer, but on account of unusual obstacles from ice this proved only partly successful. Entrance into the bay with the auxiliary schooner, *George B. Cluett*, chartered for this purpose from the Grenfell Association, was blocked until September 2, leaving less than a month's time available for surveys.

Determinations of magnetic elements on land have been continued in six parts of Africa, in as many states of South America, and in Australia, bringing the surveys of all these continental areas to a well-advanced stage.

Attention may be called to an interesting summary given by the director in his current report of work accomplished by the department during the past decade, as well as to accounts of the investigations now in progress

under the department at its laboratory, of the operations on land and sea, and of the departmental publications of the year. Of these latter, Volume II. of the "Researches of the Department of Terrestrial Magnetism," under the sub-title "Land Magnetic Observations, 1911 to 1913, and Reports on Special Researches," by L. A. Bauer and J. A. Fleming, is now in press.

THE SOLAR OBSERVATORY

With the end of the current year the Mount Wilson Solar Observatory, like most other departments of the institution, will have completed a first decade of its history. Quite appropriately, this establishment was founded at an epoch of maximum sun-spots, and a marked increase in solar activity during the past year furnishes similarly auspicious conditions for entrance into a second decade of research. But much more auspicious conditions are found in the extensive experience and in the effective equipment acquired along with the capital progress attained during this first decade. The most sanguine astronomer would have hesitated at the earlier epoch to predict that these latter conditions could be realized at the present epoch. Herein also is found a signal illustration of the superior effectiveness of establishments primarily designed for and exclusively devoted to research as compared with establishments in which research is a matter of secondary interest.

The work of the observatory for the year is much too extensive to permit of adequate summary here. But this is unnecessary, since the director's report, in addition to detailed accounts of observations, investigations and construction, gives a condensed abstract of the salient results arrived at. These results are briefly and clearly stated in 59 paragraphs. They refer to correspondingly numerous measurements, calculations and inductions made in studies of the sun and other stellar bodies whose characteristic properties are now stimulating extraordinary advances in cosmic physics.

Progress in construction of the 100-inch telescope has been made as rapidly as could be

expected in so formidable an undertaking. The delicate optical task of shaping the 100-inch mirror has been brought successfully by Mr. Ritchey to the stage of sphericity which precedes the final state of parabolization. The difficulties due to distortion of the mass of the disk, referred to in previous reports, have been overcome and other obstacles due to temperature inequalities in the optical room are likewise yielding to appropriate precautions. In the meantime the foundations for this telescope have been completed and the mounting and dome are expected to be ready for erection during the coming year. Several smaller parts and accessories for this instrument, requiring special exactness, are under construction at the shops of the observatory in Pasadena. Many additions and improvements in the apparatus already installed at the observatory have been made. The 60-foot tower telescope particularly, which was originally cheaply constructed in order to test the possible advantages of such a departure from earlier forms of telescopes, has been put in a state of efficiency comparable with that of the 150-foot tower telescope, leaving the latter free for the uses to which it is specially devoted. In these general improvements much attention has been given to rendering the plant on Mount Wilson more nearly fire-proof. The mountain road has been repaired, widened and strengthened in many parts in anticipation of the heavy traffic essential to transportation of the 100-inch telescope to its destination.

WORK OF RESEARCH ASSOCIATES AND COLLABORATORS

The variety and extent of the work carried on by research associates and collaborators has led to the widely spread but erroneous notion that the institution has entered, or is able to enter, all possible fields of investigation, and that an expert can be supplied offhand for immediate consideration of any question which the world may submit. But while such comprehensive capacity is obviously unattainable by finite means, or by any single establishment, the scope and ramifications of this work are such as to defy adequate condensation and

exposition within the limits of an administrative report. To understand this branch of the institution's activities one must at least read the titles of the reports and the publications which appear in the current year book and know something of the contributing authors and their environments. Summarily it may be stated that more than a hundred individuals have been engaged in these activities during the past year and that their work embraces a range of about thirty different subjects of research. Although attempts to draw lines of distinction between adjacent fields of advancing knowledge are alike futile and inimical to progress, it may be of interest to note with respect to these subjects that if they be classified under the two categories of descriptive sciences and mathematico-physical sciences, respectively, they will be found to be about evenly divided. It may be noted also that in this work the so-called "humanities" represent no small share, since researches have been promoted during the past year in Roman archeology, in Central American archeology, in Roman paleography, in history, in law, in linguistics and in several branches of literature. But in all this latter work the object has been not to fix, nor to accept, categories, nor to determine "shares," but to produce results of permanent value.

Referring to the individual reports and to the bibliographic lists in the current year book for accounts of the investigations and of the publications of the year in this highly diversified branch of the institution's work, it must suffice here to cite a few salient facts indicative of progress. Thus, Dr. Van Deman, in her studies of Roman archeology, has developed criteria for determining epochs and periods in the evolution of Roman construction, and hence in the evolution of Roman history. In the allied field of Roman paleography Dr. Loew has published, through the Clarendon Press, Oxford, a volume of researches under the title, "The Beneventan Script; A History of the South Italian Minuscule." The extensive researches in embryology carried on under the direction of Professor Mall, with the collaboration of a number of associates, have

proved highly productive, as shown by the publications issued and in press. Similarly, attention may be called to the fruitful studies of Dr. Osborne and Professor Mendel, which promise to throw important light on the intricate physico-chemical processes of animal nutrition and growth. The older sciences of chemistry and physics have made not less important progress through the contributions of a dozen associates and many more collaborators. A very noteworthy advance has been secured in meteorology by Professor Bjerknes through the international adoption of his methods and units for expressing meteorological data. Beginning with this calendar year and continuing up to the onset of the European war, the United States Weather Bureau issued daily weather maps of the whole northern hemisphere in conformity with these new methods and units, greatly to the advantage of theoretical and applied meteorology. The comprehensive and always highly suggestive expositions in geology and in cosmogony for which Professor Chamberlin has long been distinguished have stimulated his colleagues, Professors Michelson, Gale and Moulton, to the production of a capital contribution to geophysics in an ingenious and conclusive proof that the rigidity of the earth is about the same as that of steel. And finally, in illustration of the ease of passage from one field to another in this complex miscellany of independent researches, there may be cited the concordances of the earlier poet Horace and the later poet Spenser, now in press as numbers 202 and 189, respectively, of the institution's series of publications.

FINANCIAL RECORDS

The following list shows the departments of investigation to which the larger grants were made by the trustees at their last annual meeting and the amounts allotted from these grants by the executive committee during the year:

Department of Botanical Research.....	\$42,140
Department of Economics and Sociology.	5,000
Department of Experimental Evolution...	63,479
Geophysical Laboratory	85,500

Department of Historical Research	31,100
Department of Marine Biology	19,150
Department of Meridian Astrometry	25,180
Nutrition Laboratory	45,798
Division of Publications (office expenses).	10,000
Solar Observatory	220,892
Department of Terrestrial Magnetism	157,406
Researches in Embryology	26,900
Total	\$732,545

THE BUREAU OF MINES

IN his annual report to the secretary of the interior Director Joseph A. Holmes, of the United States Bureau of Mines, states that excellent progress has been made during the past fiscal year in the investigations of the explosibility of coal dust at the experimental mine near Bruceton, Pa. These investigations included a careful examination into the inflammability of coal dust collected from hundreds of mines in different coal fields and a systematic study of the possibility of coal-mine explosions starting from the improper use of explosives or the use of improper explosives, or from electric sparks, miners' lamps, mine fires, or other agencies.

Probably the most important feature of the year's work was the development of four types of explosion-stopping devices in which rock dust is used, as follows: Box barriers, concentrated barriers, ventilating-door barriers and ventilation-stopping barriers. The barriers were tested in strong and weak explosions and were effective in preventing propagation of flame beyond them. After being placed in a mine they are easily inspected and require little attention. Demonstrations before mining men led to inquiries from a number of companies, with a view to the erection of the devices in mines. The results of the tests at the experimental mines have shown the value of watering.

Four great explosions occurred during the year, as follows: One in the Stag Canyon mine, at Dawson, N. Mex., October 22, 1913, resulting in the death of 263 men; one at Acton, Ala., November 18, 1913, in which 24 men were killed; one at the Vulcan mine, New

Castle, Colo., December 16, 1913, in which 37 men were killed; and one at Eccles, W. Va., April 28, 1914, in which 181 lives were lost. The general ventilation in most of the mines involved in explosions was good, but the defect in certain mines was in permitting the local accumulation of gas through not bratticing up to the face of gaseous entries or working places. One of the great disasters was probably caused by the use of dynamite for blasting, and by disobedience in firing a shot or shots when miners were in the mine, in spite of the fact that an outside shot-firing system had been installed.

Other lesser disasters occurred during the year. Many shot firers lost their lives in the Pittsburgh, Kans., district, and in Oklahoma, Indiana and Iowa. Although the system of employing shot firers to fire the shots when all others are out of the mine lessens the number of deaths, yet in many districts the methods of shot firing employed are still so extremely hazardous that only the most reckless men are willing to act as shot firers. In any mine in which this system is used there seems to be no good reason why shot firing from without the mine by electrical means should not be employed, at least if permissible explosives are not used.

Director Holmes strongly urges the purchase by the government of the grounds on which the experimental mine is situated. He declares that the Bureau of Mines should own these grounds, now merely leased, in order to safeguard the large expenditure already made in developing the mine thereon and equipping it with expensive appliances.

Looking to the future, the director observes that, despite the progress made in ascertaining the nature of mine explosions and in devising methods of prevention, they still continue to occur, and it is to be feared that complete prevention will be difficult, owing to the inherent difficulty of eliminating errors of observation, judgment, or understanding from among miners or mine officials. Thus, one of the shocking disasters of the past year was brought about because of one man's willing-

ness to risk the sacrifice of not only his own life, but the lives of many others in order to gain a few tons of coal. It is difficult to meet such a case, and yet with the progress that is being made in the methods of preventing or limiting explosions, it is certain that hereafter in a well-protected mine properly cared for there will be much less danger of a widespread explosion.

THE UNIVERSITY OF CINCINNATI BUREAU OF CITY TESTS

THE Bureau of City Tests aids the city in two ways. It helps the government to purchase the best materials, by examining the dealers' samples, and, by making further tests from time to time, enables it to receive supplies of good quality throughout the year.

Cincinnati is one of the first large cities to purchase coal under competitive bidding in accordance with well-drawn specifications. All its purchases are made on the British thermal unit basis. In submitting bids, dealers guarantee a certain number of heat units per pound, and a certain percentage of ash. The cost per heat unit in the various bids is then calculated and the contracts awarded. All moisture in excess of the amount normally present is deducted from the tonnage delivered. The result of this new system has been the receiving of a good uniform grade of coal.

The bureau tested the 450 or more carloads of cement used, during the year, for various city improvements. In spite of the fact that only standard brands which have proved dependable are used, 11 carloads of cement of poor quality were rejected. The steel employed to reinforce concrete work is tested physically, and of this but one questionable sample was received.

By testing fire hose, the city saved \$11,000 on the contract of 1912, and about the same amount on that of 1914. The bureau analyzes samples without any knowledge of the bidders' prices, and contracts are let on a quality basis to the lowest bidder whose product conforms to the standard underwriters' specifications. The satisfactory performance

of the hose under heavy duty has shown the value of these examinations.

In the case of lubricating oils, also, the contracts are let to the lowest bidder whose oil conforms to the specifications of the bureau. At one time, 26 samples of oil were rejected, and it was necessary to advertise for new bids. The second set of samples were practically all up to the requirements.

The 1,164 samples examined during the past year can not all be mentioned, but here are a few that were rejected as inferior: paint, with over 20 per cent. gasoline; sand, dirty, not well graded, and unsuitable; anti-freezing compound, guaranteed free from calcium chloride, yet found on analysis to be composed entirely of calcium chloride and water; marble cleaner, high in price, and consisting entirely of washing soda; woolen blankets, supposed to contain not more than 15 per cent. of cotton, yet shown on analysis to have 30 per cent.; and sulphuric acid, containing such a high percentage of iron that it would have ruined the expensive storage batteries of the fire alarm telegraph system.

The services of the bureau are, for the most part, accepted in a cooperative spirit by dealers and manufacturers. Its reports are frequently the first analyses the dealers have seen of their products, and they have shown much interest in the results and have tried to meet the specifications. The work of the bureau has increased 80 per cent. since last year. The city departments are rapidly taking advantage of the laboratory, and the coming year will undoubtedly show a big increase in the variety, as well as in the volume, of the work submitted.

THE RETIREMENT OF CHARLES HORTON PECK

THE regents of the University of the State of New York on the retirement of Charles H. Peck from the position of New York State botanist have adopted the following minute:

The service rendered to the state by Charles Horton Peck, D.Sc., who has just retired from his position as state botanist, has been extraordinary in its fidelity, assiduity and productiveness. Dr.

Peck entered the staff of the State Museum as botanist in 1867, and from that date to the present, his service has been continuous—a period of 48 years. In 1883 the position of state botanist was created and he has been its only incumbent.

The nearly half century of his scientific activity became an epoch in the science of botany in America, by virtue of the extensive contributions which he made, not alone to the knowledge of the flora of New York but specially through his almost pioneer investigations among the fungi. His researches in this field vastly increased the sum of knowledge and established an orderly and rational classification so that his published papers, issued in the reports of the state museum, are indispensable to any student of these forms of life. The number of species discovered and described by him are counted by thousands and the additions made through his efforts to the state herbarium are so extensive that this collection of plants is to-day among the largest on the continent and of great scientific worth. By common consent of his colleagues Dr. Peck has long been recognized as the ultimate authority in mycology—the field of his special labors.

In view of these services whose value to the state can not be briefly estimated or readily expressed, the regents take this occasion to record, with their regret that the exactions of time have impelled him to retire from the service of the university and the state, their congratulations to Dr. Peck upon a life well rounded and a work well done, with their assurance of continued interest and deep regard for his welfare during the years that may remain.

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the Wesleyan University Club of New York City, on January 28, was in honor of the fiftieth anniversary of the graduation of Dr. William North Rice, professor of geology.

DR. ROBERT H. RICHARDS, professor emeritus in the Massachusetts Institute of Technology, has been awarded the gold medal of the Mining and Metallurgical Society of America in recognition of his services in the advancement of the art of ore dressing.

PROFESSOR ISALAH BOWMAN, now in charge of geography at Yale University, will at the end of the current academic year on about

July 1 remove to New York and join the staff of the American Geographical Society as director of the society's work and librarian. The geographers of the country generally will doubtless be glad to hear that this society, whose activities are constantly widening, have been able to enlist the services of Professor Bowman in the promotion of its future work.

PROFESSOR CHARLES P. BERKEY, of the department of geology, Columbia University, has been appointed as an expert to select, classify and preserve borings taken from the sites of buildings in all parts of New York City, and to prepare geologic maps of the city. The appointment comes from the board of estimate.

THE secretary of the Smithsonian Institution, with the approval of the secretary of agriculture, has appointed Dr. Charles H. T. Townsend to the honorary position of custodian of *Muscoid diptera*, in the United States National Museum.

W. L. DISTANT has resigned the editorship of the *Zoologist*.

DR. VIKTOR BÖHMERT, formerly professor of political economy and statistics at Dresden, has celebrated the sixtieth anniversary of his doctorate.

DR. JULIUS BERNSTEIN, formerly professor of physiology at Halle, has celebrated his seventy-fifth birthday.

THE council of the Geological Society, London, has this year made the following awards of medals and funds: Wollaston medal, Professor T. W. Edgeworth David, C.M.G., F.R.S.; Murchison medal, Professor W. W. Watts, F.R.S.; Lyell medal, Professor E. J. Garwood, F.R.S.; Bigsby medal, Mr. H. H. Hayden; Prestwich medal, Professor Emile Cartailhac (Toulouse); Wollaston Fund, Mr. C. B. Wedd; Murchison Fund, Mr. D. C. Evans; Lyell Fund, Mr. John Parkinson and Dr. L. Moysey; Barlow-Jameson Fund, Mr. J. G. Hamling.

THE council of the New York Academy of Medicine for 1915 is composed of the following members: Dr. Walter B. James, presi-

dent; Dr. L. Emmet Holt, Dr. S. S. Goldwater and Dr. Edward D. Fisher, vice-presidents; Dr. Charles F. Adams, recording secretary; Dr. D. Bryson Delavan, corresponding secretary; Dr. Reginald H. Sayre, treasurer; Dr. A. Alexander Smith, Dr. Charles L. Dana, Dr. John H. Huddleston, Dr. W. Gilman Thompson and Dr. Wisner R. Townend, trustees; Dr. Floyd M. Crandall, chairman of the Committee on Admissions; Dr. Thomas L. Stedman, chairman of the Committee on Library; Dr. Robert H. Halsey, assistant secretary; Dr. A. B. Judson, statistical secretary; Dr. Charles Mallory Williams, executive librarian.

A COMMITTEE on the Biological Station, of the University of Michigan, has been appointed, consisting of Professor Gleason, director of the biological station, chairman; Professor Reighard, head of the department of zoology; Professor Newcomb, head of the department of botany; Professor Guthe and Professor Kraus, deans of the graduate school, and the summer school, to consider all questions of policy, budget, staff, equipment, instruction and other matters pertaining to the welfare of the station.

PROFESSOR HENRY E. CRAMPTON, of the department of zoology, Columbia University, is spending a month in Porto Rico in the interest of the natural history survey of that island which is being conducted by the New York Academy of Sciences.

THE Pennsylvania chapter of the Society of Sigma Xi met on January 13. Professor Lightner Witmer, director of the university psychological laboratory and clinic, presided. Supper was served in Houston Hall. Members of the psychological department later gave a demonstration of experimental work in psychology and Professor Witmer presented a paper on "Psychology as a Department of Instruction."

DR. HENRY S. DRINKER, president of Lehigh University and the American Forestry Association, delivered an address at the University of Illinois on January 18, on "The Conservation of Our National Resources."

DR. FELICE FERRERO will lecture at New York University on February 19 on "Galileo and the Struggle between the Old Science and the New."

AN illustrated lecture was given on January 12, 1915, by Mr. William Bowie, inspector of Geodetic Work, U. S. Coast and Geodetic Survey, Washington, D. C., before the Engineering Club of Northwestern University, Evanston, Ill. The subject of the lecture was "Primary Triangulation and Precise Levelling."

MR. J. C. THORPE, formerly professor in the engineering faculty of the University of Illinois, gave recently there a series of four illustrated lectures on the automobile.

DR. JAGADIS CHUNDER BOSE, of Presidency College, Calcutta, gave a popular lecture on "Plant Autographs and their Revelations" at the University of Wisconsin on Friday, January 22, 1915, under the joint auspices of the Society of the Sigma Xi and the Science Club of the University of Wisconsin. A smoker at the University Club in honor of Dr. Bose followed the lecture.

THE monument on Mount Mitchell, erected twenty-six years ago in memory of Professor Elisha Mitchell, for whom the mountain was named, has been destroyed by dynamite. It is not known who committed the act. Professor Mitchell, a member of the faculty of the University of North Carolina, established the height of the peak as 6,711 feet. He eventually lost his life while exploring the mountain.

A MEMORIAL meeting in honor of Albert Smith Bickmore was held in the American Museum of Natural History on January 29, when the program included addresses by President Henry Fairfield Osborn, Mr. Joseph H. Choate, Mr. Cleveland H. Dodge, Dr. John M. Clarke and Mr. L. P. Gratacap. Professor Bickmore was in large measure responsible for the founding of the American Museum and was a leader in its educational work.

AT the recent annual public session of the Académie de médecine, Paris, the family of

Pasteur presented to the academy a portrait bust of Pasteur by Paul Dubois.

DR. CYRUS FOGG BRACKETT, professor emeritus of physics in Princeton University, died on January 29, in his eighty-second year.

DR. BENJAMIN SHARP, formerly corresponding secretary of the Philadelphia Academy of Natural Sciences and professor of invertebrate zoology there and in the University of Pennsylvania, died on January 24, at Morehead, N. C., aged fifty-six years.

DR. JULIUS WEEREN, formerly professor of metallurgy in the Berlin Technical School, has died at the age of eighty-three years.

THE death is also announced of Dr. Rudolf Fischer, director of the Coburg Museum of Natural History, and of Dr. Lothar von Frankl-Hochwart, professor of pathology of the nervous system at the University of Vienna.

AMONG those reported killed in the war are: Dr. Max Brandt, assistant in the Botanical Museum at Berlin-Dahlem; Dr. Wilhelm Schneider, assistant in the Agricultural Institute at Giessen; Dr. Werner Hirschfeldt, assistant in the Industrial Museum at Stuttgart, and Dr. Karl Pfarr, professor of mathematics and physics in the Vienna Industrial Academy.

IN answer to the manifesto of the German intellectuals, which is considered as unifying German culture and German militarism, La Société Nationale d'Acclimatation de France has decided to remove from its list of members all Germans and Austrians.

THE board of trustees of the University of Illinois has given the sum of five hundred dollars to the fund inaugurated for the purpose of erecting a laboratory at Rothamsted in commemoration of the centenary of the birth of Lawes in 1814 and of Gilbert in 1817.

THE will of Alexander A. McKay, of Chicago, bequeaths \$100,000 to the Art Institute for the maintenance and enlargement of the Munger collection of paintings, \$100,000 to the Home for Destitute Crippled Children and \$100,000 to the Mary Thomson Hospital for women and children.

At the exercises held in the Engineering Societies Building, New York, on January 27, in connection with the inauguration of the Engineering Foundation, it was announced that the initial gift had been made by Mr. Ambrose Swasey, past-president of the American Society of Mechanical Engineers, who gave \$200,000 for "the advancement of the engineering arts and sciences in all their branches to the greatest good of the engineering profession and for the benefit of mankind." Addresses were made by Mr. Gano Dunn, president of the United Engineering Society; by Dr. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching; by Dr. Robert W. Hunt, past-president of the American Institute of Mining Engineers, and by Dr. Alexander C. Humphreys, past-president of the American Society of Mechanical Engineers and president of the Stevens Institute of Technology. The administration of the fund will be intrusted to the Engineering Foundation Board, elected by the trustees of the United Engineering Society and composed of eleven members, nine from the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and two members chosen at large.

A JOINT meeting of Section G (botany) of the American Association for the Advancement of Science with the Botanical Society of America and the American Phytopathological Society was held in Philadelphia at 2 P.M., December 29, 1914. Vice-president G. P. Clinton presided. The following officers were elected. For member of the sectional committee for five years, C. S. Gager; for one year, A. D. Selby; for member of the council, L. R. Jones; for member of the general committee, W. L. Bray. The sectional committee recommended, and the association elected, W. A. Setchell as vice-president. The following papers were read:

Address of the retiring vice-president, "The Economic Trend in Botany," by H. C. Cowles.

"Foliar Evidence in Regard to the Ancestry and Early Climatic Environment of the Angiosperms"

(illustrated by lantern slides), by E. W. Sinnott and I. W. Bailey.

"Physiological Eccentricities of the Blueberry Plant" (illustrated by lantern slides), by F. V. Coville.

"Plant Autographs" (illustrated by lantern slides and experiments), by J. C. Bose.

THE twenty-seventh annual meeting of the American Association of Economic Entomologists was held at the University of Pennsylvania, December 27 to 31, 1914. The address of the president, Dr. H. T. Fernald, was delivered at the first session and the program was crowded with over forty papers, all of which were of special interest to economic workers. The section of Apiary Inspectors met at 8 P.M. on December 27 and the Section of Horticultural Inspection held its sessions at 8 P.M. on December 28 and 10 A.M. on December 29. Many papers of interest were presented at these sessions and discussions as to methods and the present status of inspection work followed. A draft of a uniform state law covering nursery and orchard inspection was favorably considered. The next annual meeting will be held at Columbus, Ohio, in connection with the annual meeting of the American Association for the Advancement of Science and the executive committee was directed to call a special meeting at San Francisco during the summer. The officers for 1915 were elected as follows: President, Professor Glenn W. Herrick, Ithaca, N. Y.; First Vice-president, Professor R. A. Cooley, Bozeman, Mont.; Second Vice-president, Professor W. E. Rumsey, Morgantown, W. Va.; Third Vice-president, Dr. E. F. Phillips, Washington, D. C.; Secretary, A. F. Burgess, Melrose Highlands, Mass. Professor J. G. Sanders, Madison, Wis., is secretary of the Section of Horticultural Inspection and Mr. N. E. Shaw, Columbus, Ohio, secretary of the Section on Apiary Inspection. A full report of the meeting will be published in the *Journal of Economic Entomology*.

A COLLECTION of Cretaceous fossils has been purchased by the department of geology and invertebrate paleontology of the American Museum of Natural History from Dr. A. Schrammen, of Hildesheim, Germany. It con-

sists of eleven hundred species of invertebrates represented by four thousand specimens which were collected from some fifty localities and fourteen geological horizons in the upper and lower Cretaceous beds of northwest Germany. The phyla and sub-phyla represented are the foraminifera, spongia, hydrozoa, anthozoa, echinoidea, annelida, brachiopoda, gastropoda, pelecypoda and cephalopoda. Among the pelecypoda and cephalopoda are to be found the type specimens of Wolleman in his work on the Cretaceous of Misburg and Nettlingen. The most valuable portion of the collection is the large number of types of siliceous sponges from the Mucronaten and Quadraten Senonian strata.

THE free lecture course of the Ottawa Field Naturalists' Club opened on November 23, with exhibits and addresses by members, in the Normal School Assembly Hall. The remainder of the program is as follows:

December 8.—"The New Zealand Peripatus—the most Ancient and Wonderful of Living Animals," by Professor E. E. Prince, Dominion commissioner of fisheries, Ottawa.

January 12.—"The Royal Botanic Gardens, Kew," by Professor R. B. Thomson, Botanical Laboratory, University of Toronto.

January 26.—"The Indians of the West Coast," by Dr. Edward Sapir, department of anthropology, Geological Survey, Ottawa.

February 9.—"Fossils," by Mr. L. D. Burling, Geological Survey, Ottawa.

February 23.—"Milk," by Mr. J. H. Grisdale, Director Experimental Farm, Ottawa.

March 9.—"Some Interesting Canadian Birds," by Dr. M. Y. Williams, Geological Survey, Ottawa.

March 23.—Annual meeting and presidential address: "The Habits of Insects in Relation to their Control," by Mr. Arthur Gibson, entomological branch, Department of Agriculture, Ottawa.

The first four meetings are at the Normal School and the last four in cooperation with the Carnegie Library in its Assembly Hall.

MR. HENRY S. WELLCOME, founder of the Wellcome Bureau of Scientific Research, in London, has announced that the bureau will provide the sum of £2,000 to be distributed in the form of prizes for the best plans and designs of a body for, and improvements in, field

motor-ambulances. The competing designs, which may be from citizens of any nation, must be received by the commission not later than June 30. Details may be obtained from the secretary of the Ambulance Construction Commission, 10 Henrietta Street, Cavendish Square, London, W.

THE *Journal* of the American Medical Association states that the New York state hospital commission which is charged with the supervision and control of the state hospitals for the insane is planning a campaign of prevention. During the past year 6,061 patients were received at the state hospitals, of whom about one quarter owed their breakdown to causes largely under their control. The plans of the commission comprise a series of short illustrated talks on mental hygiene to be delivered in different parts of the state, showing to the public the economic burden imposed on the state through insanity; the causes and prevention of insanity, and the problems of faulty heredity and environment. The plan also includes the giving of assistance to individuals in the form of advice as to how to obtain proper medical treatment and advice as to the maintenance of mental hygiene. The teaching and pathological branch of the service will be under the direction of Dr. August Hoch, New York City. The lectures will be given under the direction of the commission, with the approval of Health Commissioner Biggs.

THE spreading of rabies by infected coyotes among cattle grazing in the national forests has assumed a grave aspect, according to a report received by the forest service from the district forester in charge of the forests in Washington and Oregon. Numerous townships in eastern Oregon, it is reported, have ordered that all dogs be muzzled, lest those that have been bitten by rabid coyotes develop hydrophobia and attack human beings or domestic animals. Efforts are being made by the state authorities of Oregon to stop the spread of hydrophobia by this means and officers of the forest service are cooperating in attempts to kill off the coyotes. In one county alone a loss of three hundred head of cattle is charged to rabid coyotes.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of \$40,000 has been given by Mr. Andrew Carnegie to Allegheny College for a chemical laboratory to replace the one recently destroyed by fire.

MR. PATTEN, who has already given \$500,000 to the medical school of Northwestern University, has now added \$27,000 for scholarships.

PROFESSOR C. H. PEABODY, head of the department of naval architecture at the Massachusetts Institute of Technology, has been notified by the Aero Club of America of the establishment of an award in the form of a medal for the students at the institute. The medal is to be termed the "Aeronautical Engineers' Medal" and is for award annually for merit to a student in the graduate course in aeronautical engineering.

At the University of Chicago Dr. Frank Christian Becht has been appointed assistant professor in the department of physiology, his particular field of work being pharmacology. Professor Becht, who is a graduate of the University of Chicago, was for two years assistant professor of physiology in the University of Illinois and later assistant professor of pharmacology in the Northwestern University Medical School.

IN the medical department of the University of Oregon Dr. J. M. Connolly has resigned as professor of physiological chemistry and Dr. H. D. Haskins, of Western Reserve University, Cleveland, has been elected his successor. Dr. B. L. Arms has resigned as professor of bacteriology to accept a position in the University of Texas and Dr. W. H. Norton, of Johns Hopkins Medical School, has been appointed to the vacant position.

Two professors from Louvain University—MM. Charles Jean de Valée Poussin and Léon Dupriez—have been invited by Harvard University to deliver lectures in the second semester. The former will lecture on mathematics, the latter will give the Godkin lectures on "Proportional Representation in Belgium" and two courses.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS

IN his recent review of Maurer's "Technical Mechanics,"¹ Professor L. M. Hoskins has discussed at some length the question whether $F = ma$ or $F/F' = a/a'$ is the better form in which to introduce the "fundamental equation of mechanics." As Professor Hoskins' defense of the equation $F = ma$ is the clearest I have seen, and as I am still one of those who prefer the equation $F/F' = a/a'$, I should like to state here the advantages which this latter equation seems to me to possess.

In the first place, the qualitative notion of *force*, and the use of the *spring balance* as an instrument for the quantitative measurement of forces, may safely be assumed to be familiar to any one beginning the study of mechanics.²

The first serious problem, then, which confronts the teacher of dynamics is the problem of making the student understand the effect which a force produces when it acts on a material particle. This effect is, of course, the acceleration of the particle in the direction of the force, the exact quantitative relation being most simply stated as follows:

If a given particle is acted on at two different times by two forces F and F' , and if a

¹ SCIENCE, December 4, 1914.

² The question of the unit of force, which occupies so large a place at the very beginning of the subject in the ordinary treatment, need not be dwelt upon at this stage. To the beginner, a unit force is quite properly any force which brings the pointer of a standard spring balance to the point marked "1" on the scale, whether the instrument reads pounds, or dynes, or grams; just as a degree of temperature is, to the beginner, simply the distance between two divisions of the scale of a standard thermometer, whether that scale reads Fahrenheit, Réaumur or Centigrade. The conversion factors connecting the various degrees of temperature should indeed be stated; but the question of ultimate standards, being chiefly a question for the technician, need not be raised at this point. For further details, see the writer's "Recommendations Concerning the Units of Force," in the *Bulletin of the Society for the Promotion of Engineering Education*, June, 1913, the most important of which have already been adopted by the U. S. Bureau of Standards.

and a' are the corresponding accelerations, then $F/F' = a/a'$; that is, the accelerations are proportional to the forces.

When once this simple principle is thoroughly grasped, the student finds himself immediately in a position to attack any of the elementary problems in the dynamics of a particle (in one dimension). For, by this principle, the effect of any force on a given particle can at once be computed if the effect of any one force on that particle is known. In other words *the dynamical properties of any given particle of matter are completely determined by a single physical experiment on that particle*, and the result of such an experiment must be known or assumed with regard to every particle which enters into the discussion of a dynamical problem.³ It is the chief advantage of the equation $F/F' = a/a'$ that by its use the student is led, by the shortest possible route, into direct and vital contact with this central fact of dynamics—namely, that different bodies require different amounts of force to give them any specified acceleration. The whole further development of the science is essentially a matter of working out details, and introducing convenient terminology for such derived quantities as mass, momentum, kinetic energy, work, power, etc.

What then is the objection to the use of this equation?

Professor Hoskins expresses his objection as follows:

An equation which results from comparing the effects of different forces upon the same body can not, of course, be regarded as a complete expression of the fundamental law of motion; it is equally important to compare the effects of forces acting upon any different bodies. This of necessity brings in the body constant which most physicists call mass.

In reply to this objection I would say, in the first place, that the question whether a given equation can be regarded as a "com-

³ The "standard weight" of a particle is the force required to give the particle the "standard acceleration," 32.1740 feet per second per second; the standard weight of a composite body is defined as the sum of the standard weights of the particles of which it is composed.

plete expression of the fundamental law of motion" depends simply on whether all the theorems of dynamics can be deduced from this equation, and not on how the equation itself happens to have been derived. In the second place, I quite agree that in order to handle dynamical problems successfully we must indeed be able to discuss the "effect of different forces on different bodies"; that is, we must be able to determine the inertia, or mass, of each particle under consideration. But so also must we be able to discuss the momentum and kinetic energy of the different bodies; but that is no reason why a letter denoting mass, or momentum, or kinetic energy, should appear explicitly in the *fundamental* equation. From the point of view of scientific economy, the fewer letters *that* equation contains, the better. The mass concept, like the concept of momentum or kinetic energy, is a derived concept, both historically and practically, and it seems to me a merit of the plan here advocated that on this plan the derivative character of all these quantities is explicitly apparent in the mathematical development of the equations.

So much for what may be called the force method of beginning mechanics.

A second method of developing the whole subject might be to adopt *mass* instead of *force* as the fundamental concept—as has been done, for example, by Mach and by Boltzmann. This method seems to me, however, open to three serious objections.

First, the instrument commonly taken as the fundamental means of measuring mass—namely, the beam-balance—is essentially a *gravitational* instrument, depending for its operation on the (established or assumed) equality of the gravitational fields of force at the two ends of the beam; whereas the instrument for measuring forces, at least in a readily idealized form, is a *universal* instrument, not in any way dependent on locality. For example, if a man should be placed, in imagination, at the "point of zero gravity" between the earth and the moon, it is not at all obvious how he would proceed to measure a given mass with a beam-balance; whereas, if he had a spring

balance, in the form, for example, of a grip-testing machine, he could measure the strength of the muscles of his hand, or the attraction between two bodies, just as well under those circumstances as if he were on the surface of the earth.

Secondly, if we are dealing with only a portion of the physical universe (as is always the case in practical problems), we must either introduce "forces" to account for the action of the residual portion, or else resort to very artificial conventions in regard to "imaginary masses." (It should be noted that the "mass-acceleration" of a body can not conveniently be taken as a substitute for an external force acting upon that body; for the mass-acceleration of the body, like its momentum or kinetic energy, is a quantity inherent in the body.)

Thirdly, the approach to statics, in which the concept of mass plays no part whatever, is peculiarly awkward by this route; whereas if force is taken as the fundamental concept, the problems of statics may readily be taken up either before or after the detailed study of dynamics.

While therefore it is logically possible to choose either mass alone or force alone as the fundamental concept, the latter choice seems practically preferable.

Either the force method or the mass method, I say, is logically defensible; but the method which starts with the equation $F=ma$ is neither the force method nor the mass method. My chief objection to this hybrid equation $F=ma$ is precisely this uncertain wavering between the force concept and the mass concept as the fundamental notion of the science. This wavering is, I believe, the main source of the very real difficulties which the student experiences in regard to "units"—difficulties which are not necessarily functions of the laziness or immaturity of the student, but which are felt more keenly by those of a scientific and critical turn of mind than by those of a merely practical bent. I quite agree with Professor Hoskins that any student of dynamics ought to have sufficient intelligence to grasp the idea of a *systematic system of units*, that is, a system in which certain units

are taken as fundamental, and all others are derived; but I do think that the student has a right to expect that the quantities which appear in the so-called fundamental equation shall be the same as the quantities which are taken as fundamental in the system of units. *This is not the case with the equation $F=ma$.* The trouble with this equation is not that it contains mass, but that it contains *both force and mass*, while not both of these quantities are regarded as fundamental in the subsequent treatment.

The use of the equation $F/F' = a/a'$ seems to me, therefore, not merely a matter of practical convenience, but also a distinct advance in scientific precision of thought.

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GEOLOGIC HISTORY OF LAKE LAHONTAN¹

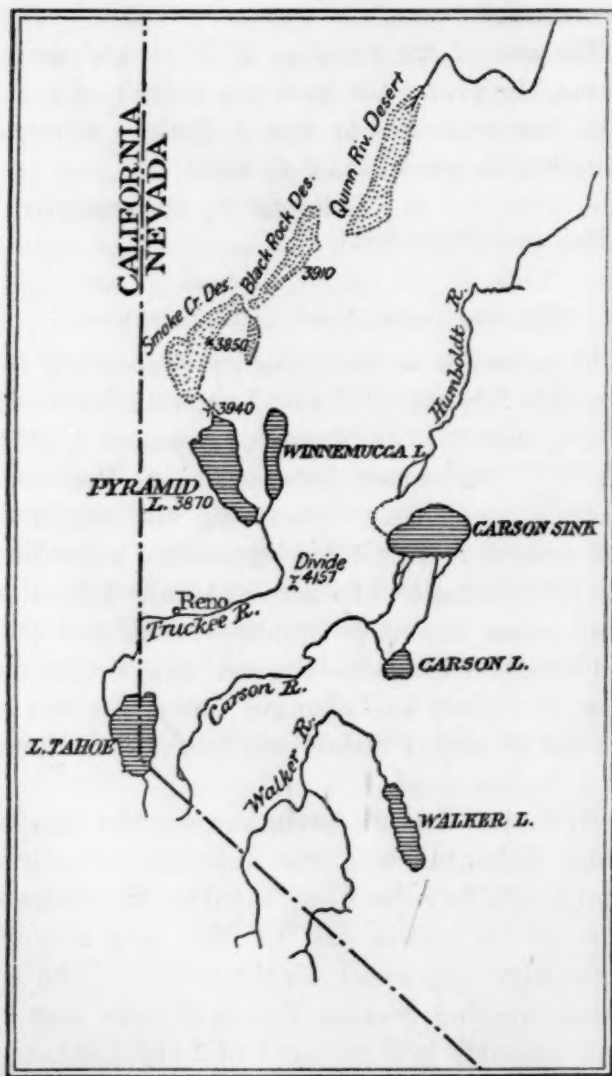
IN reference to the summary concerning the probable history of Lake Lahontan by J. C. Jones, contained in *SCIENCE*, December 4, 1914, while I am much interested in Professor Jones's conclusions concerning the origin of the tufa, I feel that his statements regarding the interpretation of the age of Lake Lahontan need some important qualifications, and that his conclusions as to the probable accumulation of salines in Lahontan waters are not at all the necessary deductions from the evidence that he has cited.

Professor Jones's estimates on the age of Lake Lahontan and the quantity of salines that might have been deposited by the evaporation of its waters fail to take into account some very important considerations. The assumption that because Pyramid Lake may be and probably is a remnant of Lake Lahontan, which has never been dried up completely, therefore its salines are an index of the age of the whole larger lake seems to me erroneous. A conception of a closer interpretation may perhaps be obtained in the following way.

No one doubts that Lake Lahontan formerly rose to a height of approximately 500 feet above present Pyramid Lake and that its

¹ Published by permission of the Director of the United States Geological Survey.

waters have since largely disappeared through diminishing water supply. The water supply that maintained the larger lake, as that which maintains the smaller lakes of the present day, came principally from a few major streams draining from the higher Sierra. Of these Truckee, Carson and Walker rivers were with little doubt, the dominating factors. The following is an outline map showing the general relation of these drainage systems.



Outline Map Showing Truckee-Pyramid Drainage System and its Former Northward Extension.

Approximate equilibrium was maintained in the larger Lake Lahontan through the balance of evaporation and inflow. Evaporation varies directly with the surface area of the water body. Inflow is supposed to have been gradually decreasing as the lake level was falling. When, however, the waters fell to the level of

any divide which would separate the basin into two or more distinct parts, the equilibrium that had been maintained for the lake body as a whole would hardly be continued in exactly proportionate relations in the two separated parts. Each part must have then established a new relation of separate inflow and evaporation ratio, and it is almost a certainty that an overflow would for a time be established from one side toward the other over the intermediate divide.

Such an overflow may have occurred over the Fernley divide from the Truckee Basin into the Carson Basin. The evidence of channels there is not very clear. At lower elevation, however, such an overflow did occur from the Pyramid Basin into the Smoke Creek and possibly beyond. The channel of this overflow is indisputably clear, broad and well defined. Its bottom is only 70 feet above the present water level of Pyramid Lake. The surface of the Smoke Creek desert to the north is below the water level of Pyramid Lake to-day. The Smoke Creek and the more northern deserts have no present perennial water supply. Although subject to floods from winter storms, they are essentially dry basins. The waters that filled these basins during the higher Lahontan stages came, with little doubt, principally from the Truckee River. The chief water supply of these broad evaporation areas came, therefore, through the more restricted basin of Pyramid Lake and flowed by way of a narrow pass at the north end of Pyramid Lake. As a late stage in the lake history, the waters of Lahontan lowered beyond the 70-foot level above present Pyramid Lake level, and a distinct overflow drainage was set up out of Pyramid toward the north. During all this time that concentration of Lahontan waters was going on, the lake in Pyramid Basin was being freshened by overflow. Only when the flow of Truckee River had diminished to such an extent that it no longer exceeded evaporation within the restricted basin of Pyramid (including Winnemucca as in all previous references) did concentration, within the Pyramid Lake waters proper, begin. Estimates of age based on this concentration may indi-

cate therefore something as to the age of this latest and perhaps shortest stage of Lahontan history, but they can hardly represent anything more. Tufa deposits above the Pyramid outlet level have no simple relation to the quantity of salines now retained in Pyramid waters, nor can any simple deduction be reasoned therefrom. If Pyramid Lake waters are comparatively fresh, that is more likely to be the result of freshening by overflow than of freshening by desiccation. However, desiccation of Lahontan waters and perhaps of concentrated saline solutions may have taken place in the dry basins to the north. Large quantities of salines were accumulated in an analogous system below the Owens River, and, owing to natural relations there, they have not since been covered up. There is a good chance that similar deposits may have been formed in some concentration sink of the Lahontan Basin, which have since been buried in playa muds.

HOYT S. GALE

WASHINGTON, D. C.

BOTANY IN THE AGRICULTURAL COLLEGES

DR. E. B. COPELAND'S article in *SCIENCE* for September 18, 1914, entitled "Botany in the Agricultural College," opens up for discussion a many-sided problem of high pedagogical importance to agriculture. While we may agree to the definition "that the raising of crops is essentially nothing more or less than applied botany," it is a pitiful commentary that what we know of the raising of crops has in the main been gained without the help of the botanist. Indeed, one of our best-known American botanists contends that problems of crop production may safely be left wholly to the argonomist and horticulturist.

The chemist infinitely more than the botanist has interested himself in the great problem of securing a larger crop return from the soil. Indeed one must give high credit to the chemists for the insistent efforts they have made to bring their science into affiliation with all other sciences and with practical industries. We have to-day almost endless subdivisions of chemistry, such as biological chem-

istry, agricultural chemistry, engineering chemistry, physiological chemistry, bacteriological chemistry, etc. There is hardly a line of human endeavor to which the chemist has not striven to apply his knowledge in a practical way. Much of the so-called agricultural chemistry is more properly plant physiology, but chemists have occupied the field with scarcely a protest from botanists. In striking contrast to the chemist, botanists have shrunk from what should be the major application of their science; namely, that of crop production. A marked exception is plant pathology along which line the best contributions of botanists to agriculture have been made. In very recent years the study of genetics as applied to agricultural crops also promises to produce much of high economic value. It is true that there are numerous texts purporting to treat of agricultural botany, but they are mostly of a character creditable to neither agriculture nor botany. The best texts that relate to agricultural botany or at least to crop production have been written not by botanists but by chemists.

Perhaps no one really questions that the study of the factors that go to make crop production is the province of plant ecology and of plant physiology, including genetics, but one may search the whole literature of these subjects without finding a single paper devoted to the relation of any one environmental factor to quantity and quality of yield, the very thing with which crop production is concerned. Botanists seem scarcely to have realized that yield is a measurable result of the same sort as the rate of growth, or the amount of water transpired, or of carbon assimilated.

Our actual knowledge of the relation of factors both external and internal to yield is very largely the work of non-botanists. Indeed, excepting for the work of chemists it is still largely confined to the facts gathered by actual experience in the growing of crops, most of it antedating the development of modern science.

Since the advent of modern science six great discoveries or lines of advance have contributed to greater crop production or at least to a

clearer understanding of the factors involved. These are as follows:

The Gaseous Food of Plants.—Knowledge of these centers about the discovery of carbon dioxide assimilation (photosynthesis) and oxygen respiration, the main points of which were cleared up by Ingen-House (1779–1796) and Senebier (1782–1800). Saussure (1804) first proved that plants combine water with carbon dioxide in carbon assimilation.

The Mineral Food of Plants.—Saussure (1804) recognized clearly the necessity of the ash constituents of plants and that these were derived from the soil. The conception, however, was much older, dating back at least to Palissy in 1563. These ideas, however, met with little acceptance until after 1840, when the writings of Liebig and the experiments of Boussingault, Salm-Harstmar and others cleared up all the important points before 1860. Liebig must be considered as the great dynamic force that impressed the importance of this knowledge on agriculture. While some of Liebig's ideas were erroneous, his writings profoundly affected agriculture and his general ideas of the importance of mineral fertilizers dominated scientific agriculture until the beginning of the present century and still exercise a potent influence. The fertilizer experiments conducted by Lawes and Gilbert at Rothamsted still remain the most extensive of their kind, and their results have contributed much to support Liebig's theory.

The Organic Food of Plants (Nitrogen).—Liebig believed that all ordinary plants obtained their nitrogen directly from the ammonia in the air, but Boussingault (1851–5) proved that various plants would not thrive in a soil containing all essential elements but nitrogen, but grew normally if nitrates were added.

While the fact had been known long previously that ammonia became changed into nitrates in soil, Schlosing and Muntz (1877) first proved that it was due to microorganisms, which were finally isolated by Winogradsky in 1890.

Hellriegel (1888) demonstrated that legumes are able to utilize atmospheric nitrogen through the agency of bacteria in the root nodules. It

was previously known that these plants could obtain more nitrogen than was present in the soil.

Plant Breeding.—Three other discoveries have led to great improvement in our crop plants themselves. These are: (1) The proof of the sexuality of plants by Camerarius 1691–4; (2) the hybridization of plants by Kolreuter, 1760–1770; (3) the discovery of the laws of hybridization, Mendel, 1865.

Improvement in Mechanical Appliances.—The development of improved machinery for the tillage of the soil, the sowing of the seed, and the harvesting of the crop has had a profound influence both in increasing the amount and decreasing the cost of production. The invention and improvement of agricultural machinery has been the work of a long list of inventors.

Control of Insects and Diseases.—The important methods for the direct control of insects and plant diseases center about the discovery of Bordeaux mixture by Millardet in 1885; of the use of Paris green for biting insects beginning about 1868; the value of kerosene emulsion for sucking insects about 1877; and the development of fumigation with hydrocyanic-acid gas, 1886–1888.

Indirect methods of control have been greatly advanced by the investigations of both entomologists and plant pathologists.

Of these six lines of advance three are due almost wholly to chemists, one to mechanics, one wholly to botanists, and one partly to botanists and partly to entomologists. It may be argued that the chemists' contributions are really plant physiology, but this does not alter the fact that the work was done by chemists and that further research into the food of plants, at least of crop plants, is still largely directed by chemists and not by plant physiologists.

At the 1914 session of the Graduate School of Agriculture held at the University of Missouri an incidental discussion led to a general expression of opinion regarding the training of American agronomists. There was complete agreement that the botanical side of their training is wholly inadequate. Indeed with

the exception of plant pathology it is exceedingly difficult to find graduates in botany whose training has given them either a taste or a qualification for the innumerable problems surrounding crop production. Almost none take the U. S. Civil Service examinations, the result being that the positions are mostly filled by graduates in agronomy with but meager botanical training.

The result of this condition of affairs is detrimental to the advance both of botany and of agronomy. The young botanist is neither trained nor encouraged to look upon the problems of crop production as the legitimate and greatest field for his future activities. Conversely, agronomy suffers because far too few botanists lend their aid to the study of plants under cultivation.

The charge has sometimes been made that botanists purposely avoid grappling with the enormously difficult physiological and ecological problems that every agronomist and horticulturist encounters. I do not believe that American botanists have ever consciously taken this attitude, but they have been willing to leave the work largely to chemists and others of very limited botanical training. In short, they have not asserted their rights to this field of plant phenomena nor proven them by actual accomplishment.

Botany has progressed greatly in America in the past twenty years, in spite of the fact that it has woefully neglected its greatest application; namely, crop production.

It is difficult to disagree with Dr. Copeland's proposition "that the best scientific foundation for plant industry is a knowledge of plant physiology," except to add that equally necessary is a knowledge of the adaptations of each plant, which is ecology. The fact remains, however, that plant industry or crop production far antedates botanical science, and most of its progress has been purely empirical; that even yet our knowledge of the physiology and ecology of any one crop plant is woefully incomplete.

I would go still further than Dr. Copeland, however, and assert that the whole field of plant culture or crop production is one of plant

ecology and plant physiology. Until this is recognized by botanists progress in crop production will continue to be largely the work of non-botanists.

C. V. PIPER

U. S. DEPARTMENT OF AGRICULTURE

IN REGARD TO THE POISONING OF TREES BY
POTASSIC CYANIDE

IN SCIENCE of October 9, 1914, was published a short letter telling of a successful attempt at poisoning the cottony cushion scale by inserting cyanide of potassium in a hole bored in the trunk of the tree. I have since received a number of letters asking for further information regarding my "process," and telling me of numerous cases where trees have been killed by poisoning the sap with something beside potassic cyanide. I would accordingly like to take this opportunity of stating that I am not experimenting in either entomology or horticulture; that I have no process, and that I gave in my letter to SCIENCE a plain statement of the method and results of my experiment. I did this in the hope that it might serve as a suggestion to others who are working in the same field.

I was told by several of my colleagues who are working in biological subjects that any poison fatal to insects would kill a tree before I put the cyanide in the trees, and I have read in a recent number of SCIENCE of the destructive effects of putting potassic cyanide and something else under the bark of fruit trees. I have accordingly chopped down the peach tree referred to in my former letter and have examined both the wood and the bark around the hole in which the cyanide was inserted. In both the wood and the bark there was a discoloration around the hole extending less than one eighth of an inch. Outside of this ring I could notice no change in either. I am not positive that as great an effect would not have been produced if the hole had been left empty. One proof that the bark was not seriously poisoned about the hole was seen in the fact that it had begun to grow over the opening. This is also true in the case of the broom and the orange tree referred to in the previous letter. The peach tree was cut down

ten months after the cyanide had been put into it.

FERNANDO SANFORD

QUOTATIONS

THE ORGANIZATION OF SCIENCE

JUST before the beginning of the war much fruitful discussion was going on in the columns of *Nature*, the *Morning Post* and *Science Progress* on the subject of the encouragement of science; and those who are interested in the theme should read Dr. R. S. Woodward's address on the needs of research, delivered on the occasion of the dedication of the Marine Biological Laboratory, Woods Hole, Massachusetts (*SCIENCE*, August 14, 1914).

Dr. Woodward begins by exposing some of the popular fallacies regarding research—that it “is akin to necromancy”; and that “the more remarkable results of research are produced not by the better balanced minds, but by aberrant types of mind popularly designated by that word of ghostly, if not ghastly, implications, namely ‘genius.’” He has also exposed the absurdity that research institutions should busy themselves in soliciting suggestions from the amateur public outside, that is “in casting drag-nets in the wide world of thought, or in dredging, as biologists would say, with the expectation that out of the vast slimy miscellanies thus collected there will be found by the aid of a corps of patient examiners some precious sediments of truth.” He thinks that “important advances in knowledge are far more likely to issue from the expert than from the inexpert in research.”

Dr. Woodward traverses the idea “that research is a harmless and a fruitless diversion in the business of education”; and gives some figures as to the comparative expenditure of the United States on education and research respectively.

The number of higher, or degree-giving, establishments in the United States is now upwards of six hundred; the aggregate annual income of these is upwards of one hundred millions of dollars; and the number of officials connected with them is upwards of thirty thousand. On the other hand, the number of independent research organizations in

the United States is less than half a dozen; their aggregate annual income is less than two million dollars; and the number of officials primarily connected with them is less than five hundred.

Something very like this holds also in Britain, and indeed throughout the world. Men can not be made to understand, even with the astonishing results which investigation has placed before us, the supreme importance of such effort. They still conceive that it is more important to teach boys how to do things than actually to get the things done.

The war now raging will at least demonstrate one thing to humanity—that in war, at least, the scientific attitude, the careful investigation of details, the preliminary preparation, and the well-thought-out procedure bring success, where the absence of these leads only to disaster. So also in everything. After all, the necessity for research is the most evident of all propositions. But the question (which I hope will receive still more careful attention when the war is over) is, What can the state do to make the machinery of investigation the most efficient possible? The mere citing of popular misconceptions is not enough; we need to have specific programs. The October number of *Science Progress* contains one such program, which I hope will receive the attention of men of science. Whether all the items are accepted or not remains to be seen; but until the discussion is earnestly undertaken, we can scarcely hope that the state will give more help than it has done hitherto. Dr. Woodward puts his finger upon a weak point in men of science as a body. “We are,” he says, “as a class of too recent monastic descent to fit comfortably in our present social environment.” That is just it. We are not strong enough in making our demands heard; and, in my opinion, this is not a virtue, but a neglect of duty.—Sir Ronald Ross in *Nature*.

SCIENTIFIC BOOKS

Fauna Ibérica. Mamíferos. By ANGEL CABRERA. Published by the Museo Nacional de Ciencias Naturales, Madrid, September 25, 1914. 8vo. Pp. xviii + 446; 143 figures in the text and 22 colored plates.

This work is the first thoroughly accurate and complete catalogue of the mammals of the Iberian peninsula and the Balearic Islands which has been published. It properly includes the marine mammalia of the surrounding seas, which, as the author justly remarks, "are as much entitled to be regarded as forming a part of the mammalian fauna of the region as the marine birds and birds of passage are entitled to be reckoned as belonging to its avifauna."

The author also includes under the Primates an account of the ape of Gibraltar, *Macaca sylvanus* (Linné), stating with excellent logic, that, whether these animals were originally introduced from Africa, as contended by some, or whether existing as survivors of their race, which once was widely spread over Europe, as is testified by paleontological evidence, they have been from time immemorial domiciled upon the Rock of Gibraltar, and are therefore truly a part of the peninsular fauna.

The appearance of Mr. Gerrit S. Miller's "Catalogue of the Mammals of Western Europe," recently published by the trustees of the British Museum, occurred when the work we are reviewing was about half-written, but as Miller's book is in English, and only gives the terrestrial species found in Spain, in many cases simply citing them as occurring on the peninsula, the writer has not felt himself deterred by the more extensive Catalogue of his learned American friend from issuing the present work.

Investigation of the pages of this book shows that there are one hundred and twenty-two species or subspecies of mammalia, which occur in the feral state on the peninsula. They are distributed as follows:

Orders	Genera	Species and Subspecies
Insectivora	7	17
Chiroptera	9	21
Carnivora	14	24
Primates	1	1
Rodentia	11	35
Artiodactyla	6	12
Cetacea	11	12
Total	59	122

From the foregoing it is plain that the peninsula possesses a relatively extensive mammalian fauna. The area of Spain, Portugal and the Balearic Islands somewhat exceeds the area of New England, the Middle States, Maryland and Virginia combined. The number of species of mammals occurring in the Iberian region indicates almost as rich a fauna as that occurring in the northeastern portion of the United States. One reason for the relative richness of the mammalian fauna of the peninsula is found in the extremely diversified character of its surface, in which there is the greatest variety of climates, ranging from that of the alpine summits of the Pyrenees and Sierras to the hot subtropical valleys of the south and east. Another factor is the probable survival in portions of this region of species elsewhere extinct in Europe and allied to those of north Africa. The genera *Macaca*, *Genetta* and *Mungos* may, it is true, be due to immigration from north Africa, but are regarded by Trouessart and others as probably representing survivals from a Tertiary fauna, which elsewhere in Europe has become extinct.

A very interesting feature of the Iberian fauna is the fact that through long isolation many forms have become subspecifically differentiated. The ibex and the chamois of Spain are distinctly different from those of Switzerland and the Alps of Italy, and analogous differences in pelage, and even in form, are revealed in other genera. This fact is interestingly set forth in the pages of the work before us.

For Spanish readers and for those in other lands who desire to acquaint themselves with the mammalian fauna of Spain and Portugal this book is especially to be commended. Written in a singularly lucid and agreeable style, embodying the results of the very latest studies, and beautifully illustrated by the author himself, who is not only a learned zoologist, but a most skilful artist and draughtsman, the work leaves a most charming impression upon the mind of the student. It is in its way a model, and signalizes the great ad-

vance along the lines of scientific investigation which is being made in Spain under the wise and intelligent guidance of its enlightened sovereign. There was a time, not so long ago, when we did not look to Spain for advanced information along purely scientific lines; but that day has passed, and there has arisen in her institutions of learning a generation of young men trained in the most modern methods of observation and research, who are destined to give this noble people as high a standing in the realms of science as has been achieved by the students of other lands. Among the young men who are working successfully in this direction none stands higher than the indefatigable and talented author of the work before us.

W. J. HOLLAND

CARNEGIE MUSEUM,
December 28, 1914

The Modern High School: Its Administration and Extension. Edited by CHARLES HUGHES JOHNSTON, Ph.D. (Harvard), Professor of Secondary Education in the University of Illinois. New York: Charles Scribner's Sons, 1914. Pp. xviii + 847.

The present work is a companion volume to "High School Education" which appeared two years ago under the editorship of Professor Johnston. The earlier book deals with the evaluation and organization of high-school studies; the present with the social administration of the high school. A third volume is announced which will treat the problem of supervision, especially that of class teaching.

In the volume under review, the editor has sought to make the cooperative plan of treatment yield a well-organized body of material bearing upon the chief problems of high-school administration. He frankly takes the position that the primary purpose of the high school is utilitarian and social: in a democracy like ours, high-school education is a necessity and not a luxury. Even the secondary functions, such as the cultural, esthetic, moral and religious, must be worked over in the light of modern social needs and social ideals. The conscious purpose of the editor, therefore, has

been threefold: first, to establish more firmly the idea that the aim of the high school is social; second, to determine the relation of the high school to the other educational agencies of a democracy; and, third, to show, largely through the interpretation of concrete examples, how the work of students might be so administered that it would have the maximum socializing effect upon them. The thirty chapters are written by twenty-eight different authors, representing the various groups of specialists interested in high-school problems.

Part I. deals with "The Institutional Relationships of the High School." A chapter here is devoted to each of the following topics: the high school as a social enterprise; the legal status of the high school; business efficiency in high-school administration; the relation of the high school to the elementary school, to the college, and to the industrial life of the community. The contributors of these chapters are Dr. Snedden and Mr. Kingsley of the Massachusetts State Board of Education; Mr. Hanger, superintendent of schools, Rossville, Kansas; Mr. Josselyn, associate professor of school administration, University of Kansas; and Dr. Carlton, professor of economics and history, Albion College. In the discussion of the second and third topics, the need of expert service in both state and local school administration is forcibly brought out. Mr. Josselyn's treatment of the articulation of the high school to the elementary school is based upon the idea that waste must be eliminated in the lower grades and that the upper grade work must be differentiated so as to integrate with the different lines of work now being offered in the high school. His charts upon the latter point are suggestive. Mr. Kingsley's discussion of the relation between high school and college contains one interesting suggestion; namely, that the high school ought to help the students select their colleges or universities and then guide their election of studies to this end. Perhaps the most difficult relationship of all, that of the high school to the industrial life of the community, receives but twenty of the two hundred and eight pages in this part. However,

the long chapter on continuation work later in the book supplements this and might have been included here.

Part II., entitled "The More Intimate Specialized Relationships of High School Work," has to do with the socialization of the curriculum, class-room management and study, and with the bringing of the home and community into more vital relationship. The authors of these chapters are Dr. Scott and Miss Williams, of the Boston Normal School; Mr. Hall-Quest, assistant in education, University of Illinois; Mr. Wiener, principal of Central Commercial and Manual Training High School, Newark, New Jersey; Mary V. Grice, founder of Home and School League, Philadelphia; and Mr. Olinger, principal Westminster Hall, Lawrence, Kansas. These chapters are rich in illustrative material. The chapter by Miss Williams describing the way she transformed her class in physiology into an active social group for the investigation of vital questions in community hygiene should be read by every high-school teacher. In Mr. Hall-Quest's article on the direction of study, all the chief schemes of "supervised study" are reviewed. The chapter by Mary V. Grice on the "Home and School Association" is exceptionally strong because of its pointed and practical suggestions.

Part III. takes up the "Definite Internal Expressions of the Social Nature and Socializing Function of the High School." The topics treated are the internal government of the school, the improvement of teachers in service, the guidance of the social activities of the high school, athletics, debating, school paper and fraternities. The social point of view is consistently followed in all the discussions. A large number of different means of dealing with these activities now in operation are described. The chapter on "High-School Journalism" is well worth careful reading by any one on the advisory board of a school paper.

Part IV. brings together a group of "Additional Socializing Functions of the Modern High School." The following are the topics

with authors: The High School as a Social Center, by Dr. Perry, of the Russell Sage Foundation; Continuation Work, by Dr. Davis, University of Michigan; High-School Library, by Florence Hopkins, librarian Central High School, Detroit; Vocational Guidance, by Meyer Bloomfield, director of Boston Vocation Bureau; Avocational Guidance, by Dr. Ruediger, of George Washington University; Cooperation in the Teaching of English, by Professor Hosic, of Chicago Normal; High-School Hygiene, by Dr. Rapeer, New York Training School; The School as an Art Center of the Community, by Ella Bond Johnston, chairman art department, General Federation of Women's Clubs; The Moral Agencies affecting High-school Students, by Mr. Hanna, state supervisor of High Schools, Illinois; and The Religious Life of the High School Student, by Professor Wilm, of Wells College. For the average teacher and principal, certain of these chapters are especially helpful, since they contain vital material on topics comparatively new. Notable in this respect are the treatments of the high-school library, the high school as an art center, avocational guidance and cooperation in the teaching of English.

In spite of the clear purpose in the editor's mind, the cooperative method of treatment has failed in one respect. Most of the contributors lay the theoretical groundwork for their discussion; and while the material is good, the reader still finds himself becoming very tired of repetitions. If close readers alone were to use the book, one hundred and fifty pages or more might be eliminated without doing great violence to the work. The part headings, too, are somewhat artificial and strained and go little way toward helping establish standard captions under which to discuss school administration. Aside from these weaknesses, the book contains the best body of assembled material on high-school administration. Excepting a small number of the more general chapters and a considerable number of introductory paragraphs in others, the editor has realized his purpose—"a survey of policies, examples and suggestions of ways and means of making

the strictly socializing work of our actual high schools more definite, more effective and more nearly universal." The sixty-seven pages of bibliography at the close of the book deserve the highest praise. The titles are carefully selected, well arranged, and in part annotated. The editor has rendered a great service to students of secondary education, especially those offering courses in the subject.

CLAYTON C. KOHL

PLANT AUTOGRAPHS¹

THE importance of investigations on physiology of plants lies in the fact that it is only by the study of the simpler phenomena of irritability in the vegetal organisms that it is possible to elucidate the more complex physiological reactions in the animal. The difficulty of investigation lies in the apparent immobility of the plant. It is often impossible by visual inspection to distinguish even between specimens, one of which is alive and the other killed. Means have, therefore, to be discovered by which the plant itself is made to reveal its internal condition, and changes of that condition, by characteristic signals recorded by it. These responsive reactions may manifest themselves in change of form or in change of electric conditions. In his investigations the author has employed both methods of mechanical and electric response.

In recording mechanical response great error is introduced from friction of the writer against the recording surface. This has been overcome in the author's Resonant Recorder, where the record consists of a series of intermittent dots due to the vibration of the writing point. In this manner it is possible to record time-intervals as short as a thousandth part of a second. Moreover in order to eliminate completely all personal equation, the apparatus has been made perfectly automatic. Thus the plant attached to the recording apparatus is automatically excited by a stimulus absolutely constant. In answer to this it

¹Abstract of a paper read before Section G of the American Association for the Advancement of Science at the Philadelphia meeting, by Professor J. C. Bose.

makes its own responsive record, goes through its period of recovery and embarks on the same cycle over again without assistance at any point from the observer.

Mimosa exhibits a remarkable periodic variation of excitability; the response being practically abolished in the early hours of the morning, the sensibility is gradually increased to a maximum by noon. The latent period of the leaf is one six hundredth part of a second. Crucial tests of the excitatory character of transmitted impulse are afforded by physiological blocks produced by the local application of cold, of poison and electrotonic block. These prove that the transmission of excitation in *Mimosa* is a process fundamentally similar to that occurring in the animal. The effects of drugs on plants are remarkably similar to the effects on animal tissues. The characteristics of the rhythmic tissues in animals and plants are precisely similar. There is hardly a single phenomenon of irritability observed in the animal, which is not also to be found in the plant.

SPECIAL ARTICLES

INHERITANCE IN THE HONEY BEE

MORE or less time has been devoted by the writer, during the past four years, to a study of inheritance in the honey bee, as a project under the Adams Fund. Innumerable obstacles to the progress of this investigation have presented themselves, but sufficient data have accumulated to justify the announcement of a few interesting points.

The matings have been made, for the most part, at an isolated mating station on the Gulf Coast prairie, about forty miles northwest of Houston, Texas. The location of the station is almost ideal for this purpose, for there are no trees or shrubs affording shelter for bees and no bees occur except those purposely taken to the mating station.

The matings thus far have been confined to crosses between the Italian and Carniolan races. As is well known, the pure bees of the former race are distinctly yellow, while those of the latter are more or less gray, but always, when pure, devoid of yellow color. For the

primary crosses stocks were selected which had been under observation for several generations without having shown any indication of impurity.

Pure Italian queens mated to Carniolan drones produce workers and queens which are indistinguishable, so far as color is concerned, from the parent Italian stock: that is, in the F_1 generation of this, the "primary," cross, the yellow color is completely dominant. In the reciprocal cross, in which Carniolan queens are mated to Italian drones, the yellow color is also dominant, but not as completely so as in the primary cross: the F_1 queens and workers show nearly, but not quite, as much yellow color as the parent Italian stock. The significance of this in practical bee-breeding is at once apparent. For years professional queen-breeders have assumed that if an Italian queen throws workers which show the typical Italian coloring it is *prima facie* evidence that she has been purely mated. From the above results it is evident that such is not necessarily the case, for such a queen might have mated to either an Italian or Carniolan drone (or even, presumably, to a black drone), and in either case her workers would have the typical Italian color. The purity of an Italian queen's mating therefore can not be determined by an examination of her workers. Further reference to this is made below. The production of yellow workers by a pure Carniolan queen, on the other hand, immediately stamps her as having been impurely mated.

There is also excellent evidence as to the inheritance of characteristics other than color. For example, the marked proclivity of the Carniolans to use wax instead of propolis for sealing crevices, fastening frames together, attaching hive-covers to frames, etc., comes dominantly to the surface in the F_1 generation of the primary cross. In the F_1 generation of the reciprocal cross this trait is also much more in evidence than in the pure Italian race, though not as completely dominant as in the case of the primary cross.

It seems to be a well-established law of heredity that an individual always produces gametes of the same kind as those of which

it is itself composed. With this law the queen-bee appears to comply without exception. As the drone is produced parthenogenetically he is essentially a gamete and behaves as such in inheritance, at least so far as the color factor is concerned. Pure Italian queens mated to Carniolan drones produce only Italian drones; and Carniolan queens mated to Italian drones produce only Carniolan drones. This is strictly in accordance with the theory of Dzierzon. However, the daughters of Italian queens which have mated to Carniolan drones produce both Italian and Carniolan drones, produce them in equal numbers, and do not produce any other kind. The F_1 queens of the reciprocal cross likewise produce drones of these two kinds and in equal numbers. This is in accordance with the theoretical expectation under Mendelian law. If the constitution of a pure Italian queen be represented by II and of a pure Carniolan queen by CC, the former will produce gametes I and I, and the latter, gametes C and C, these being Italian and Carniolan drones, respectively. A hybrid queen, however, has the constitution IC and produces gametes I and C in equal numbers, these of course materializing as Italian and Carniolan drones. The practical application of this is that the only test of an Italian queen's mating is found in the color of the drones produced by her daughters.

Another interesting consideration is that the production of an F_1 drone seems to be an impossibility and this, in turn, makes the production of a strict F_2 generation look like another impossibility. Beekeepers will at once argue that drones intermediate in color occur in nature, and such is the case. However, drones from purely mated queens are known to vary widely in color and this may possibly explain the occurrence of intermediate coloring. We are still in ignorance regarding the causes of this variation, and it is hoped that further data from the mating-station will throw more light on this as well as on other phases of this interesting problem.

WILMON NEWELL

COLLEGE STATION, TEXAS,
December 18, 1914

TILLITE IN NEW HAMPSHIRE

IN 1910 while spending the summer at Sugar Hill, New Hampshire, I came across a formation which appeared to me to be tillite. The Rev. S. S. Nickerson, of Sugar Hill, had a glacial-boulder of conglomerate near his house which looked as if made up of glacial pebbles. Mr. Nickerson described an exposure of conglomerate which he had seen in Lyman, 12 miles west of Sugar Hill, several years before. I visited this locality with Mr. Nickerson. The best outcrop found is about half a mile north of Young's pond by the side of a little schoolhouse, in the town of Lyman. I examined the formation and was immediately impressed with its glacial appearance. There was no stratification and the included rock fragments of various kinds scattered through an argillaceous matrix were of all sizes up to 6 feet in diameter. There were very few rounded pebbles, most of the fragments being angular and subangular. Here and there large masses of slate, greatly contorted, were found. One of them measured 6 feet long by 4 feet wide on the two exposed dimensions. These slate masses were so like the slate lumps found by me in the Squantum tillite near Boston,¹ that I could not avoid the conclusion that this formation might be tillite also.

On account of the very great shearing and distortion which these rocks have undergone—much greater than the Squantum tillite has been through—it will be impossible to hope for any signs of striations. Even the concave fractures so common on glaciated pebbles in till, and in the Squantum tillite, have been rendered unrecognizable. The general appearance of the rock and the distorted slate fragments are the only criteria so far found to determine the origin of this formation, and the prospects are not very bright for finding any very definite proof. To a glacial geologist, however, the appearance of the rock is almost conclusively glacial.

The thickness of this till-like section can not be less than 100 feet and is probably much

¹ See *Bulletin of the Museum of Comparative Zoology*, Vol. LVI., No. 2, "The Squantum Tillite," by Robert W. Sayles, pp. 148-155, 1914.

greater. The eastern contact rock is an argillaceous schist with a northeast and southwest strike and a thickness of over 1,000 feet. On the west the contact rock is conglomerate, with water-worn pebbles and some signs of stratification. The thickness of this conglomerate is uncertain, probably several hundred feet.

A few days after the examination of this section I found the "Geology of New Hampshire," by Charles H. Hitchcock, in the small library at Sugar Hill. On page 302, of Volume 2, the following description of this rock is given:

"There is a curious conglomerate west of Rev. C. Corning's, in North Lyman, lying adjacent to the Lyman group, and supposed formerly to constitute a part of it. It resembles a mass of common drift, because the pebbles are so numerous and miscellaneous arranged. They consist of both the white and green schists, and dip south 52° east. The pebbles are mostly of large size, one measuring 2 feet long and 5 inches wide. On the top of Mormon Hill, nearly two miles east of this exposure I found a very coarse conglomerate with strike N. 58° E. lying on the northwest side of clay slates dipping N. 47° W. It is probable that these two exposures belong to the same formation which runs athwart the Lyman group, and may possibly join a very coarse supposed Helderberg conglomerate in Littleton to be described presently."

These words were written long before the word "tillite" had been introduced by Professor Penck, and before the idea of rocks with a glacial origin had entered the minds of American geologists.

In the summer of 1911 I invited my friend, Dr. F. H. Lahee, to investigate with me in this region, for the purpose of finding out, if possible, the age of the formation under discussion. He spent two summers making a careful field study of all the formations. The main results of his work, without a discussion of the rock described in this paper, were published by him in the *American Journal of Science*, Vol. XXXVI., September, 1913, "Geology of the New Fossiliferous Horizon and the Underlying Rocks, in Littleton, New Hampshire." The age of the supposed tillite is still much in doubt, on account of faulting and unconformity. Professor Lakee thinks the

rock older than Permian. Hitchcock in his first writings on this region called the formation Huronian, but 30 years later referred it to the Cambrian or Ordovician. In his later opinion, however, he was not sure.² Further work will be necessary on this most difficult locality to place all the formations in their proper stratigraphical positions.

ROBERT W. SAYLES

HARVARD UNIVERSITY

THE PHILADELPHIA MEETING OF THE AMERICAN ANTHROPOLOGICAL ASSOCIATION

THE annual meeting of the American Anthropological Association was held at the University Museum, Philadelphia, December 28-31, 1914, in affiliation with the American Folk-Lore Society and Section H of the American Association for the Advancement of Science. The attendance was satisfactory, and a rather extensive program was presented. It was decided to hold a special session in San Francisco, August 2-7, and to empower Professor A. L. Kroeber, of the University of California, to make all arrangements relating to the meeting. A decision as to the place of the next annual meeting was referred to the executive committee. The secretary of the Committee on Phonetics, Dr. E. Sapir, read the committee's report in abstract, and the members were instructed to publish the entire report in whatever form seemed most appropriate.

The following officers for 1915 were elected by acclamation:

President: F. W. Hodge, Bureau of American Ethnology.

Vice-president, 1915: Clark Wissler, American Museum of Natural History.

Vice-president, 1916: A. L. Kroeber, University of California.

Vice-president, 1917: George B. Gordon, University of Pennsylvania.

Vice-president, 1918: Berthold Laufer, Field Museum, Chicago.

Secretary: George Grant MacCurdy, Yale University.

Treasurer: B. T. B. Hyde, New York City.

Editor: Pliny E. Goddard, American Museum of Natural History.

Associate Editors: J. R. Swanton, R. H. Lowie.

Executive Committee: A. M. Tozzer, E. Sapir, W. J. Fewkes.

² (1) Hitchcock, C. H., "Geology of New Hampshire," Vol. 2, p. 50, 1877, and (2) "Geology of Littleton, N. H.," reprint from the "History of Littleton," pp. 11 and 29, 1905.

Council: F. W. Putnam, F. Boas, W. H. Holmes, W. J. Fewkes, R. B. Dixon, F. W. Hodge, C. Wissler, A. L. Kroeber, G. B. Gordon, B. Laufer, G. MacCurdy, B. T. B. Hyde (ex-officio); A. E. Jenks, S. A. Barrett, W. Hough, A. Hrdlicka, A. M. Tozzer, F. G. Speck, A. A. Goldenweiser, E. A. Hooton, A. V. Kidder, F. C. Cole (1915); Byron Cummings, G. H. Pepper, W. C. Farabee, J. R. Swanton, G. G. Heye, H. J. Spinden, T. T. Waterman, C. M. Barbeau, W. D. Wallis, A. B. Lewis, Stansbury Hagar (1916); W. C. Mills, H. Montgomery, C. B. Moore, W. K. Moorehead, C. Peabody, C. C. Willoughby, T. Michelson, A. B. Skinner, M. H. Saville (1917); A. C. Fletcher, C. P. Bowditch, S. Culin, R. H. Lowie, C. H. Hawes, E. Sapir, N. C. Nelson, H. Bingham, J. A. Mason, G. A. Dorsey, E. W. Gifford (1918).

The sectional committee of Section H recommended the names of twenty-eight members for fellowship, and the council of the American Association for the Advancement of Science duly elected them. The recommendation of the sectional committee, that Professor George M. Stratton, of the University of California, be elected vice-president of the section for the ensuing year, was likewise approved by the general committee. Professor L. Witmer was elected a member of the council; Dr. P. E. Goddard a member of the general committee, and Professor F. Boas a member of the sectional committee to serve five years.

The American Folk-Lore Society reelected Dr. P. E. Goddard president and Professor C. Peabody secretary, and elected A. B. Skinner assistant secretary.

The address of the retiring vice-president of Section H, Professor Pillsbury, on "The Function and Test of Definition and Method in Psychology" will be published in *SCIENCE*; Dr. Goddard's presidential address before the Folk-Lore Society on "The Relation of Folk-Lore to Anthropology" will appear in *The Journal of American Folk-Lore*.

A number of the papers presented dealt with problems of general interest. Geheimrat Professor Felix von Luschan, who appeared as a guest of the Association, delivered a lecture on "Convergency." He dwelt on the importance of this originally biological concept in the field of anthropology, where both somatological and cultural resemblances can often be ranged in this category rather than under the caption of independent development. Dr. A. B. Lewis, in his paper on "Some Native Industries from New Guinea," passed from a descriptive account to significant remarks on the process of diffusion, as indicated by Oceanian data. The distribution of certain techniques in this area points not so much

to either independent origin or wholesale borrowing, but rather to stimulation of new specialization on the basis of the diffusion of general ideas. The ever-vexing problem of historical unity or diversity of origin led to a clash of opinions in the linguistic field. Dr. Sapir, in a paper on "The Nadene Languages," sought to establish the genetic connection of Tlingit, Haida and Athapascan. This led to a methodological discussion by Drs. Boas and Goddard, who assumed a skeptical attitude. A significant contribution to archeological chronology was presented in Mr. N. C. Nelson's "Chronological Data on the Rio Grande Pueblos." The data pointing to a difference in age of the ruins concerned are to some extent of an architectural nature, but the main line of evidence consists of no less than four distinguishable types of pottery in distinctly stratified refuse deposits. "The Knowledge of Primitive Man" was dealt with by Dr. A. A. Goldenweiser. It is true, he contended, that primitive man has developed theories that seem to differentiate him sharply from civilized humanity—a fact strongly urged by Lévy-Bruhl. But it must not be forgotten that in addition primitive man possesses a far from inappreciable body of technical, astronomical, biological knowledge that forms the foundation of our own sciences and should become the object of more systematic study by ethnologists. In another paper Dr. Goldenweiser suggested a definite "Sociological Terminology in Ethnology," of restricted range. Professor Boas called attention to the fact that a definite nomenclature tends to hide real problems, while specific misgivings as to some of the speaker's suggestions were voiced by Drs. Sapir and Lowie. In a lecture on "Exogamy and the Classificatory System" Dr. R. H. Lowie adduced North American evidence corroborative of Rivers's theory that the so-called classificatory system, or rather the merging of collateral and lineal lines of descent, is a function of exogamy.

The following additional papers were presented: James R. Nies, "Anthropological Evidence contained in some Cuneiform Signs"; Charles Peabody, "Notes on Prehistoric Palestine and Syria"; Byron Cummings, "Kivas of the Cliff Dwellers in the San Juan Drainage"; George G. Heye and George H. Pepper, "The Exploration of a Delaware Burial Place near Montague, N. J."; Stansbury Hagar, "The Maya Day Sign, Manik"; R. B. Dixon, "Statistics Relating to the Vitality and Fecundity of the American Indian Obtained by the Last Census"; A. B. Lewis, "Prepared

Human Heads from New Guinea"; A. M. Tozzer, "The Excavation of a Pre-Aztec Site in the Valley of Mexico"; *id.*, "The Work of the International School of Archeology and Ethnology in Mexico for 1913-1914"; Hiram Bingham, "Types of Machu Picchu Pottery"; *id.*, "Prob-lematical Stone Objects found at Machu Picchu"; *id.*, "Results of Investigations Concerning the History of Machu Picchu"; Marshall H. Saville, "Preliminary Account of Archeological Researches along the Pacific Coast of Colombia"; Adela Breton, "Some Pages from the Memorial de Tepetlaostoc and the Painted Map from Metlatoyuca in the British Museum"; F. Boas, "Demonstration of a Map showing the Dialects of the Salish Languages"; George Hempl, "The Origin of European Alphabetic Writing"; H. J. Spinden, "Nahua Influence in Salvador and Costa Rica"; Stith Thompson, "European Tales Among the North American Indians"; Phillips Barry, "The Magic Boat"; C. H. Hawes, "Dartmouth College Ethnological Collection"; F. G. Speck, "The Eastern Algonkin Wabanaki Confederacy"; F. W. Waugh, "Some Comparative Notes on Iroquois Medicine"; T. Michelson, "Notes on the Stockbridge Indians"; *id.*, "Problems in Algonquian Ethnology."

The following papers were read by title: Robert B. Bean, "The Growth of the Head and Face in American (White), German-American, and Filipino Children"; *id.*, "Some Ears and Types of Men"; G. G. MacCurdy, "The Passing of a Connecticut Rock-Shelter"; W. J. Wintemberg, "An Iroquoian Site in Eastern Ontario"; Robert Gorham Fuller, "Observations on a Series of Crania from the Stone Graves of Tennessee"; A. L. Kroeber, "Eighteen Professions"; William H. Holmes, "The Place of Archeology in Human History"; C. Wissler, "The Diffusion of Modern Ceremonies in the Plains Area"; *id.*, "Types of Clothing and their Distribution in the Plains Area"; Reed Smith, "1914 Additions to the Traditional Ballads in the United States"; C. M. Barbeau, "Huron-Wyandot Mythology"; Middleton Smith, "The Psychology of Humor, Wit and Ridicule"; Charles W. Furlong, "The Tribes of the Fuegian Archipelago"; A. B. Skinner, "Ethnology of the Eastern Dakota"; J. R. Swanton, "The Creek Clans and the Square Ground"; P. Radin, "On the Relationship of the Languages of Mexico"; *id.*, "Literary Aspects of North American Mythology."

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Acting Secretary, in absence of
GEORGE GRANT MACCURDY